SCIENCE

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THE OUTLOOK FOR SCIENCE[1]

THE most remote origins of science are to be sought in the early observations of primitive races of men. At first phenomena were probably registered in memory with no attempt to relate them other than by means of the hypothesis that they were due to the will of some intelligence akin to that of man. It appears that an enormous period of time elapsed before men began to conceive even the possibility that these phenomena were bound together by laws through which they were capable of explanation. A long preparation of experience seems to have been necessary before this conception could arise.

But we are not to look back upon this period as barren. It gave rise to one thing at least of essential importance, namely, the effort to relate phenomena in such a way as to make the universe intelligible. It matters little what particular explanation was first offered; but it was a thing of profound importance to have conceived the possibility of any explanation at all.

The preliminary forms of this conception have probably been lost from the view of history. The first name which appears on the record as we now have it and indeed the first name in the history of European thought is that of the Greek philosopher Thales. He sought to go behind the great multiplicity of phenomena in the hope of finding a deep unity from which all difference had been evolved and by means of which these phenomena might themselves be explained.

It is interesting to note particularly that in this first attempt to make the universe intelligible Thales sought to ground everything in a single material cause. This he found in water. How he related it to the plurality of phenomena is not known. It is certain, how-

[1] An address delivered to the Indiana Chapter of the Society of Sigma Xi on November 5, 1914.

ever, that he set his contemporaries to thinking along a new line. Other explanations were offered each of which sought to find a basis for all phenomena in some one material substance. One of these was air. Another was a hypothetical substance having properties between those of air and fire. We need not mention more of these. It is sufficient to observe that it was hard to offer a reason why one of them afforded the desired explanation rather than another. One outcome, however, of this discussion among these thinkers is very interesting, namely, the conclusion reached by Anaxagoras that all things have existed in a sort of way from the beginning, but that originally they were in infinitesimally small fragments of themselves, endless in number and inextricably combined throughout the universe but devoid of arrangement. These fragments were the seeds of all things. The gradual adjustments of these among themselves have given rise to all phenomena whatsoever.

Thus ended the first search among the Greeks for a single material cause of all things. There followed a long period in which science no longer proposed to itself such an ambitious problem. In modern times each worker has been content to consider a narrow range of phenomena and seek a particular explanation. For a long time we have proceeded in this way with the study of special problems. In recent years we have been brought back in a most surprising manner to face the old problem of the Greeks. In the meantime our chemists and physicists had studied all known substances and had found that they were composed of about seventy elements.

When we had become thoroughly convinced that these elements were separate and distinct, radioactive substances made their appearance in our laboratories and we were compelled to revise our old opinions. Emanations of various sorts were then eagerly examined and before long it was realized that various of these seventy elements were giving off the same sort of electrons, so that they must certainly have something in common. Moreover, some elements were actually transformed into others. In view of these facts one could hardly fail to raise the inquiry as to whether all elements are not indeed only different combinations of electrons. The speculative hypotheses of the old Greeks in the earliest period of scientific history thus stand prominently before our physicists in their laboratories to-day. The striking elements of agreement between a theory asserting that all matter is made up of electrons and that of Anaxagoras with its primal fragments of things are very remarkable, to say the least. What is done with this old problem in its new form will certainly exert a marked influence on scientific progress.

Looking from a certain point of view one may say that the great problem of science is to find out just what unities do exist among phenomena. If we can not trace everything to one cause we shall at least seek to find those general laws by means of which the greatest number of phenomena may be explained. This we must do in self-defense; otherwise we should soon be helpless before the enormous volume of science. Only if we grasp the great fundamentals, which include many particulars, shall we be able to continue our progress.

Economy of energy is one of the great demands which will press itself upon our attention with increasing force as the body of science is enlarged. One way to realize this economy is to make permanent conquests which remain for all time our possession. This is done in the science of mathematics. Other sciences should strive for the same permanence, but be all the time ready to grant that it has not been attained. No law of phenomena should ever be counted so well established as not to be subjected to every further test which ingenuity can devise. Over and over again our fundamental steps of progress have been taken in the most surprising way in fields of thought where everything had apparently been examined with the greatest care.

The way in which the mathematician has gained economy of energy through permanence of result is instructive. He confines his attention within limits so restricted that he may define his terms and ideas with the sharpest precision. In doing this it may be necessary to leave out of account a considerable part of

the problem in which he is interested. But the results which he obtains are permanent; these in turn he may use to arrive at tentative conclusions concerning the other parts of his problem.

In like manner it may be necessary that a theory in experimental science should restrict itself to a certain point of view in order to remain scientific. The range of phenomena, even in a restricted field, may be too great to be taken account of at once. Therefore some elements are left entirely out of mind until considerable progress has been made with the investigation. This was done in the case of the kinetic theory of gases, the size of the molecules being taken into consideration only after extensive investigations had been made in which this element was ignored.

Such a plan of procedure will cause us no uneasiness if we remember the guiding purpose of physical science. It does not attempt to afford us an explanation of the essence of things; if it did so it would find itself amidst inexplicable difficulty from the beginning. Its purpose, on the other hand, is to give direction to our researches into details and to afford us the best means of acting on things and of predicting phenomena.

It may very well happen that a "false" theory will serve this purpose better than a "true" one. In other words, a theory which is in agreement with only a narrow range of facts may be better for us at a given time than one which agrees with a much wider range. The one more nearly perfect, in the absolute sense, may be out of reach of our proper understanding or at least beyond any means of experimental verification at our command.

As a first example of this let us consider the case of a savage who has been accustomed to take the animistic view of nature. It may very well be true that his primitive theory brings helpful ideas and enables him to get around in his world and interpret it in a satisfactory way. His observations have little of precision about them and consequently they do not clash with his theory. To this creature the Newtonian law of gravitation would be meaningless and useless. For him it could serve none of the ends for which we employ that or any other scientific theory. For him to make such a hypothesis as this would be distinctly unscientific.

Another case in point is the old Greek theory of which we spoke a few moments ago. According to it all matter had a unique origin, and a primary task of the philosopher was to discover what substance gives rise to all others by the combination of its parts. None of the answers which they were able to arrive at, as we have seen, were of such character as to give them greater power to act on things or to predict phenomena. In accordance with a true scientific instinct the theory was therefore allowed to drop out of mind. Nowadays it has been revived in a different form because in this form it now seems capable of being subjected to experimental examination.

Probably the best example of the difficulties of a position where speculation has outrun observation is afforded by the atomic theory of the ancients, a theory which is very close in its general aspects to that which is usually accepted at the present day. In recent times this theory has given rise to the most important and far-reaching investigations. It has in a remarkable degree all the characteristics of a useful theory, which we enumerated above, and in many ways has proved itself vital in experimental investigations. Among the ancients, however, it seems to have led to nothing but speculations and disputings. It was too far in advance of other parts of scientific theory to be amenable to experimental investigation. Though essentially in agreement with facts, as we understand the matter to-day, it yet led to no scientific conquests in ancient times.

Such examples as these remind us that we should not set ourselves the task of finding the "true" explanation of things. From a scientific point of view our plans should be far less ambitious. This is a point, it seems to me, which we should be careful not to lose sight of. What we want to do is to frame general laws which to us appear to be the simplest we can find and which have the following three properties: they are in accord-

ance with all known phenomena; they enable us to predict events; they suggest to us new experimental investigations to carry out. We shall not undertake to say that these laws are true in any absolute sense. Furthermore, it will not cause us any uneasiness if we find a new phenomenon which contradicts one or more of them. That is a thing to be expected if we are making progress. It will be no surprise if a principle which was developed to relate past experiences should turn out to be insufficient to deal with future experiences.

The experimentalist is thus continually finding things which run counter to his preconceived opinions, whether they are based on unreasoned intuition or on large collections of facts. It is important to us to analyze the way in which men have heretofore met such situations. They will continually arise in our experience as long as we are making progress. From the most superficial examination we may see that they have often stood in the way of advancement.

When an opinion has gained a strong hold on our imagination it may obstinately refuse to be removed although it causes us grave trouble to keep it in agreement with facts or even leads us into contradictions from which we can find no escape. The early history of astronomy furnishes us with a good illustration of this matter. The Pythagoreans undertook to make precise the central problem of this science. Plato followed with other work along the same line. By means of a considerable range of speculation and reasoning, which would have little weight with us today and therefore need not be repeated now, these philosophers came to the conclusion that uniform motion in a circle is the most perfect of all motions, and therefore must be that of celestial bodies. But it was obvious that a simple motion of this kind for each of these bodies was insufficient to explain their positions at various times. Thus from the outset it was apparent that it would be necessary to consider the compounding of various circular motions in order to account for observed facts. Therefore those early thinkers confidently proposed as the fundamental inquiry of theoretical astronomy the following questions: How can we explain astronomical movements by means of uniform circular motions?

It was well to have this problem proposed, although it turned out to be incapable of solution. Directly or indirectly it has exerted a profound influence on the progress of every science. As long as the body of observation was sufficiently meager men could labor with some hope of answering the question as proposed. At first it was sufficient to compound two or three motions. After observations became more exact it was necessary to put together four or five circular motions for one body and to introduce numerous hypothetical spheres in order to have something to move along the requisite circular arcs. This thing continued till the explanations bewildered one with their complexity. Still men held to their preconceived idea of circular motion for many centuries until Kepler finally broke the spell by the discovery of the three laws on which modern theoretical astronomy is based. It is instructive to all scientific workers, I believe, to ponder the experience of men in dealing with this old problem.

As another example of the influence of preconceived opinion consider the old belief of chemists that the formation of organic compounds was conditioned by a so-called vital force. In accordance with this theory it should be impossible to synthesize organic compounds from dead matter. But in 1828 Wöhler succeeded with the synthesis of urea. But the belief in the necessity of a vital force died hard. Men tried to get around the new fact by supposing that urea stands midway between organic and inorganic substances. But the accumulation of other cases in which organic compounds had been synthesized finally led to the rejection of vital force as a factor in purely chemical relations.

A very curious case which was obviously in disagreement with facts is afforded by the old phlogiston theory of combustion. According to this theory combustibility is due to a principle called phlogiston, which is present in all combustible bodies in an amount proportional

to their degree of combustibility. The operation of burning was simply equivalent to the liberation of the phlogiston. This theory dominated chemical thought for more than a generation, notwithstanding its inherent defect due to the fact that the products of combustion were heavier than the original substance, whereas the theory demanded that they should be lighter.

I have purposely illustrated the influence of preconceived opinion by means of some of the older examples. Many others might be given. In fact, in nearly all our theories relative to experimental phenomena we introduce important elements not suggested by our observations, but by our own esthetic sense. Witness the introduction of the ether in so much of physical theory. A man sometimes feels that he is putting into his theory nothing except what observation has directed. This, I believe, is always a delusion. Moreover, I think that it is an undesirable thing to attempt. It is not true that observations compel any one theory. In fact, as Poincaré has shown, there is an infinite number of explanations of any finite set of facts. From among this enormous totality we must select the explanation which is most satisfying for us from considerations of convenience or from the demands of the esthetic sense. This is actually what we always do. It should be done consciously.

Now it is clear that any body of doctrine built up in this way is in danger of being seriously in error, and therefore it is necessary for us often to reexamine our theories with a view to ascertaining whether the preconceptions which were wrought into them still appear to be justifiable. This is one of the hardest tasks of the scientist. Accordingly he often waits long in the presence of his difficulties before he tries to overcome them by this heroic method. He is usually more averse to the surgical knife operating among his ideas than on the members of his body, however hard he may try to overcome this disposition.

It is no surprise that this is so. The race was too long practical before it sought to become scientific for us to make the change readily. Some one has defined the practical man as one who practises the errors of his forefathers. He is tied down to his preconceived opinions, not being enough of a dreamer to get away from them. He will be able to get through the world without receiving many hard knocks; but he will not inaugurate profound changes and advances in human life. That will always be left for the scientist who refuses to be satisfied with what is and who is always seeking a new sort of fact to destroy his own and his contemporaries' equilibrium.

But this will be harder for him to do as the years pass. In fact it is true in one respect that the problems of the scientist are increasing in difficulty. As the mass of accumulated observations grows larger there are fewer essentially new facts to be discovered. And when it becomes necessary to devise a new theory it is harder to make it fit into and explain the great array of recorded phenomena. But this affords no ground for pessimism, as we shall show in a moment. Moreover, it carries with it a reward of its own. If a theory can be made to fit into the facts as now known it has a good chance of doing service for some time, and this from the reason that it has been made to explain so many things already.

But there was a real advantage to be gained from the meagerness of data in the old time. It was not so difficult to theorize with some appearance of success, and therefore men the more readily conceived the possibility of relating things according to law and the more easily set up a tentative explanation. I have no doubt that speculative philosophy, for instance, has profited in times past by the meagerness of the data on which its speculations were based. The very fact that no large body of observed occurrences stood in the way of speculation emboldened men to launch forth upon what otherwise would have been a forbidding sea.

But confidence in setting forth did not save from danger and shipwreck. For some time we have known that no conclusion in science

is safe unless it is built up from a large collection of facts. Our philosophers are beginning to realize that the same sort of thing is true in their realm, and hence we should not be surprised to see science itself conquer a large part of the ancient domain of philosophy. Progress in this direction has already been sufficient for men to begin to speak definitely of "the scientific method in philosophy." Such indeed is the title of the volume containing the Lowell Lectures delivered by Bertrand Russell in Boston last spring. The adherents of this new method believe that it represents in philosophy "the same kind of advance as was introduced into physics by Galileo: the substitution of piecemeal, detailed and verifiable results for large untested generalities recommended only by a certain appeal to imagination." This method has gradually crept into philosophy through a critical scrutiny of mathematics. It is imbued with the essential spirit of a theoretical science based on experimental results.

The fact that the scientific method is encroaching upon the domain of philosophy will raise the question as to how far it is able to go towards solving the problems of metaphysics. It appears already to have been quite successful in dealing with the notions of continuity and infinity. But that it shall undertake to solve all the metaphysical problems is unlikely. What is more probable is that it shall pronounce many of them meaningless or else out of reach of exact investigation and consequently leave them to one side.

Returning now to the more special problems of science proper, let us inquire what is the present outlook for definite achievement in research. There are various types of answers to this question and various types of persons who make them. Some take an enthusiastically optimistic view of the situation. Others are pessimistic, though there seems to be less ground for pessimism now than there was fifteen or twenty years ago. Some of these pessimists believe that research is about to run out, at least in their own fields. They see nothing vital remaining to be done or else they feel helpless in the presence of a problem which is conceived. The persons who have this pessimistic feeling may be divided into two classes.

In the first place, there are those who have not attempted research and therefore have no first-hand acquaintance with its methods and problems and difficulties. At most they can see as through a glass darkly. One feels that their pessimism will prevent them from ever seeing as face to face. Some of these persons are so pronounced in their views as to believe that research has never made any really significant progress. They reach this opinion from quasi-philosophical considerations and not from an examination of the facts. It is unnecessary to refute these persons. Their judgment of matters of research properly has no weight at all among men who are actually engaged in extending the bounds of knowledge.

In the second place, our group of pessimists include those who have themselves undertaken research and have been unsuccessful in their venture. There is an obvious reason for their opinion; but it is one which makes no contribution toward answering the question as to the general outlook for definite achievement in research.

Over against these pessimists there is a large and ever-increasing body of enthusiastic researchers. They believe in to-morrow because they saw good things yesterday and have seen better ones to-day. It is hard for them to perceive how any one can fail to feel the expansion of growth in the midst of which he is living. To them it is the most natural of all expectations to think that we are just now on the eve of great developments. What is the ground of their confidence, insofar as it is not temperamental?

It is not that they have a vision of easy conquest. It can not be doubted for a moment that difficulties of the most serious sort confront us in scientific investigations. No one of these optimists can see the goal which he confidently expects science to attain. But there are some things which he can see, namely, past achievements and the circum-

stances under which the work has heretofore made progress.

It is the examination of these things which gives rise to such optimism, and especially of those of them which belong to the last few years. We shall not have time to take up these matters in detail so as to examine the events one by one; we can only indicate their general characteristics, leaving it to the reader to supply the concrete individual instances.

Let us ask: What is the leading characteristic, in the infancy of their development, of those processes and results of thought which have most profoundly influenced human progress?

To attempt a full discussion of this problem would carry us too far aside. But a partial answer lies close at hand. Great steps forward have usually been taken in a way which was not expected and in a field of mental activity where the processes and results of thought had assumed an apparently fixed form. In such a region there had been for a time a seething of thought with frequent eruption of new theory; but at last everything had come to a state of quiescence. Apparently, nothing more was to be expected from that quarter. But the appearance was false; a fresh development came with astonishing swiftness.

Often at a moment when least expected new and vital discoveries are made. Thought is ruthlessly jostled out of the rut into which it has fallen. A state of uncertainty and uneasiness ensues. Restlessly the mind seeks new verities to which to fix itself. There is a general shaking up of its content of thought. The old bottles are not strong enough for the new wine of new truth and are burst asunder. This quickening of thought, this expansion into larger conception, this is the leading characteristic of fundamental advances in human thinking.

This which I have just described is to my mind precisely the leading characteristic of several important theories of modern science. There has been a ruthless shaking up of the whole substructure; uncertainty, and even uneasiness, have arisen in many quarters; in some fields there is no longer any one who believes that he knows what should be expected. An eminent scientist who, a few years ago, was authority for the statement that the future advancement of physics was to be looked for in the fifth decimal place is now advising younger men to try all sorts of "fool experiments." This is an indication of the spirit of the times. We find indeed that our power over nature is increasing and that we can make better predictions than ever before; but we no longer have the faith which we once had in our theoretical explanations.

In recent years one surprise after another has come with such rapidity that we no longer know what it is to be orthodox in scientific theory.

A new liberty—some will say, a new license—in theorizing has sprung up everywhere. The boldness of some of the new hypotheses is amazing, even disconcerting. If ever they come into a general acceptance they will give rise to an expansive development of the human mind in virtue of our attempt to understand the philosophic significance of the new movements. They will require revision of our ways of thinking, and will thus mark a new stage in human progress.

An examination of the discoveries which have given rise to this sort of thing will lead to the observation that many of them were made in such unexpected ways that one almost feels as if they came about by accident. In fact there seems to be a certain element of haphazard in all scientific discoveries. We have not yet learned how to make a systematic and all-embracing search through fields of thought either old or new. Our best discoveries are frequently made in territory over which we have trodden many times before.

What are we to conclude from the fact that our particular discoveries are so often hit upon almost by chance and that we have looked about so nearly at random and have found such things? Let us answer by raising another question. Suppose that it had been true twenty years ago that only a few fundamental facts yet remained to be discov-

ered, in physics for instance, and suppose further that men had set about, as indeed they have, to try all sorts of "fool experiments"; then, in view of the infinite multiplicity of things which they might have tried, what is the probability that they would have discovered all or nearly all of the fundamentally new facts which twenty years ago were yet to be brought to light? According to the theory of probability, this chance is practically nil. Let us put with this result the further fact that for many hundred years men had been looking at phenomena with care and had not found the important facts discovered in this twenty-year period. Then, in view of all this we can only conclude that it is extremely probable that there is yet an unlimited, or at least a very great, number of fundamental facts still to be discovered. We can hardly refuse to draw the further conclusion that all we know at present is only a mere fragment of what we shall ultimately find out.

We can indicate the immediate prospect more precisely by a consideration of the present state of physics which I believe now stands in an enviable position with respect to all science and all philosophy—in fact, with respect to every body of doctrine whose development makes for human progress. In recent years it has undergone a marvelous rejuvenation, into the detail of which we can not now enter. It requires no eye of prophecy to see that this is certain to make itself felt in valuable advances in astronomy and geology and to lead the way to new and fundamental conquests in chemistry and biology. All branches of the sciences of phenomena should sit at the feet of the new physics in order to get in touch with her most recent discoveries and to carry them over to their consequences in other special domains of research.

All indications point to magnificent conquests of research in the immediate future and for many years to come. An analysis of the past gives us a strong assurance that there are many important things yet to be discovered. The progress of the preceding decade shows that we have in hand tools that have been effective, and we can hardly suppose that they have just now finished their work when we consider the sort of achievements which have just been made. Notwithstanding that the war in Europe will cut off many young men of enthusiasm and power and hinder the work of all investigators on that continent, it is yet true that there is an enthusiastic body of workers, especially in America, still carrying on their silent conquests which will take a place alongside the great achievements of the race. It is a pleasure to know that there is such an organization as this society to foster a work of this sort. I am glad that so many of us have entered upon the undertaking already and I hope that young men and women of promise will see a possibility of labor toward the good of the whole future of mankind and will lay their lives and their energies upon the altar of service in science.

R. D. Carmichael

THE PHILOSOPHY OF BIOLOGY: VITALISM VERSUS MECHANISM[1]

In comparison with mathematicians and physicists, biologists have contributed little to philosophical literature, notwithstanding the close relations existing between their science and philosophy. The most notable instance of recent years has been Driesch, whose attempts at philosophical commentary and interpretation seem, however, to have given on the whole little satisfaction to either biologists or philosophers. Bergson—"the biological philosopher," as Driesch calls him—bases much of his doctrine on biological data, and the use of such data appears to be becoming more frequent among philosophers. Lately professed biologists have shown somewhat more tendency to enter the field of philosophical discussion; and it is remarkable that when they do so they often adopt a vitalistic point of view. Haldane's "Mechanism, Life and Personality" is one recent illustration of this tendency, and the present book of Johnstone's is another.

[1] "The Philosophy of Biology," by James Johnstone, D.Sc., Cambridge University Press, 1914.

As the author himself explains, the point of view and methods of treatment are largely those suggested by Driesch and Bergson. The book is not long; there are eight chapters entitled, respectively, the Conceptual World, the Organism as a Mechanism, the Activities of the Organism, the Vital Impetus, the Individual and the Species, Transformism, the Meaning of Evolution, the Organic and the Inorganic; there is also an appendix with a brief account of the chief principles of energetics. In the table of contents is given a concise yet complete and connected summary of each chapter. This makes it unnecessary for the reviewer to summarize the whole book, and this review will be confined chiefly to a criticism of the author's main contentions and especially of the arguments by which he seeks to support his vitalistic thesis.

The first chapter discusses the relation of conceptual reasoning to reality. The author agrees with Bergson in regarding intellect as essentially a biological function, which reacts in a characteristic manner on the flux of reality and dissociates this more or less arbitrarily into detached elements; the aim of this dissociation is practical—namely, to facilitate definite or effective action on the part of the organism. Scientific method follows an essentially similar plan; our scientific descriptions and formulations of natural processes are conceptual schemata; their correspondence with real nature is inevitably inexact; they necessarily simplify and diagrammatize. In reality, however, nature can not be regarded as a composite of separate processes, individually susceptible of exact description in intellectual terms, and interconnected in ways which are similarly definite and quantitatively determinable; it is rather a continuous or flux-like unitary activity, exhibiting a progressive and irreversible trend; hence actual duration is distinct from the conceptual time of physicists. Now the intellect, in making its characteristic conceptual transformation, neglects or ignores or even falsifies much of the essential character of reality. This is how it becomes possible to view the living organism as a mechanism: the physiologist substitutes for the real living organism the conception of a system of physico-chemical processes, conceived as interconnected in a definite way; by doing so he is enabled to view the organism as essentially a physico-chemical mechanism; but we must note that the conceptual elements out of which he builds up his scientific view of the organism inevitably determine the nature of this end-conception, which is physico-chemical or mechanistic only because his method does not permit him to regard the organism as anything but a summation or integration of the physico-chemical processes that form the elements of his synthesis. As a result, however, he really misses what is most distinctive of living beings, and reaches a point of view which is not only inadequate for scientific purposes—as shown by the failure of physico-chemical analysis in the case of many vital processes—but in its very nature far removed from the actuality itself.

This is the fundamental criticism which the author makes of the accepted scientific methods of investigating life-phenomena. In the remainder of his book he interprets the characteristics of the organism and of the evolutionary process from this general or Bergsonian point of view. He sees operative in life a distinctive agency, corresponding to the "élan vital" of Bergson or the entelechy of Driesch, which acts typically in a direction contrary to that characteristic of inorganic processes; these latter tend toward homogeneity and dissipation of energy; in living organisms, on the contrary, evolution tends toward the production of diversity, and the tendency of entropy to strive toward a maximum may be compensated or even reversed by vital activity. "Life, when we regard it from the point of view of energetics, appears as a tendency which is opposed to that which we see to be characteristic of inorganic processes. . . . The effect of the movement which we call inorganic is toward the abolition of diversities, while that which we call life is toward the maintenance of diversities. They are movements which are opposite in their direction" (page 314). It is here that the author's views become most seriously open to scientific attack; the evidence

that the second law of thermodynamics does not always apply to life-processes is certainly inadequate; there is exact experimental evidence that the first law (that of conservation) holds for organisms; and the storing of solar energy by chlorophyll is in no sense evidence that the second law is evaded. There seems in fact to be a fundamental misconception in this part of the author's argument. He holds that life may play the part of the Maxwellian demon under appropriate circumstances (page 118), and defends this view on the ground that the laws of molecular physics are statistical in their nature and might be different if it were possible to control the movements of individual molecules; such control, it is implied, is possible to the vital entelechy. It seems to the reviewer, however, that the application of the second law to gases or solutions implies simply a tendency of the freely moving molecules to uniform distribution; the resulting homogeneity can be prevented only by adding energy to, or abstracting it from, part of the system; even Maxwell's demon has to work a partition which resists the impact of the faster molecules—a consideration which shows that any coordination or sorting of molecules would in itself involve the performance of work. Johnstone's supposition, however, is that the vital entelechy can, without altering the total energy of the system, control or direct the otherwise uncoordinated motions of the individual molecules; and that the purposive or directed character of the individual organism's life, and also of the whole organic or evolutionary process, is conditional on the existence of such an agency, and is indeed the characteristic expression of its activity. He thus maintains, in effect, that physiological processes are unintelligible unless we can assume the existence of some such directive agency peculiar to life, which can vary the nature, intensity and direction of the physico-chemical processes and coordinate them in the interest of the organism. This "entelechy" is what imparts their distinctive quality to life-phenomena.

It has long seemed to the reviewer that failures or deficiencies in the physiological analysis of complex or delicately adjusted functions form no sufficient ground for rejecting such methods of investigation as in their nature inadequate. Vitalists, however, are fond of this kind of attack; and both Haldane and Johnstone adduce instances which they believe make it incredible that physico-chemical processes, unguided by an entelechy, could ever form the basis of vitality. At present our knowledge of the physiology of embryonic development and of certain types of form-regulation is especially defective; and such phenomena are cited more frequently than any others as proving the inadequacy of physico-chemical analysis. Driesch's "logical proof of vitalism," quoted in the present book, is an instance of this tendency; even relatively simple processes like muscular contraction and nerve conduction remain largely mysterious, and we find also scepticism as to the possibility of any satisfactory account of these processes in physico-chemical terms (*cf.* page 100 of the present book).

A twofold reply to this type of vitalistic argument may be given. First, it is to be noted that the failure of physico-chemical analysis is often due to mere complexity of condition. But complexity, as such, does not introduce any essentially new problems; it simply makes more difficult, and may for a time make impossible, the task of analysis. Provided that the more elementary processes forming a complex process are characterized by *constancy* in their nature and in the conditions of their occurrence, any degree of complexity in the total process is possible. Ordinary experience with complex artificial systems, of a mechanical or other kind, verifies this contention; we find that there is no limit other than that set by practical expediency to the complexity of a system whose component parts operate and interact in a constant manner. In all such cases smaller and simpler parts are taken as units from which higher compound units are built up, and these secondary units are then similarly utilized for the construction of more complex systems; these may be still further combined, and so on. The one indispensable condition is that there should be an essential invariability in the operation

and interaction of the parts of the system. Similarly with life and its manifestations: the complexity of organisms and of organic processes, so far from making us despair of the adequacy of physico-chemical analysis in dealing with vital phenomena, seems in fact to the reviewer the surest witness to their essential adequacy. For these vital processes, however complex and mysterious, are unfailingly *constant* in their normal manifestation; one has only to reflect on what is continually happening in the body of a healthy man in order to realize this; and the stability of conditions thus shown surely has the same basis as have the stability and constancy of the simpler non-vital processes which we everywhere find as components of the vital. The basis of this stability is simply the exactitude with which natural processes repeat themselves under identical conditions.[2] If this were not the case, how could a physico-chemical system of the vast complexity of (*e. g.*) the human organism ever exhibit stable existence or constant action? It is impossible to doubt that the constancy with which complex physiological processes operate is conditional on the constancy of the simpler component processes—those which form the subject-matter of physico-chemical science. Constancy in the character, mode of action, and interconnection of the component substances and processes is evidently indispensable to the constancy or stability of the product of their integration, the living organism. We find in fact that mysterious and unintelligible physiological processes, *e. g.*, the regeneration of the lens in the eye of a salamander, recur under appropriate conditions with the same constancy as the simplest and most intelligible, say the formation of a retinal image by that same lens. It is clear that if we admit the adequacy of physico-chemical methods in the one case we must be prepared to do so in the other.

Second, it is to be noted that the organic processes show evidence by their very limitations that the underlying mechanisms are strictly physico-chemical in character. Thus vitalists call especial attention to the instances of development and form-regulation which have so far baffled all attempts at physico-chemical analysis. "Does not this mean," Johnstone asks, "that in biology we observe the working of factors which are not physico-chemical ones?" The limits to the regulative power are less frequently cited by vitalists; yet surely evidence of this kind is equally relevant. Why, if an entelechy can restore the amputated arm of a salamander, can not it perform a similar miracle in the case of a man? The fact is that nothing is proved by citing such cases. But on the whole they seem clearly to imply that the properties of the organism are throughout the properties of physico-chemical systems, differing from inorganic systems simply in their complexity. The reviewer knows of no facts which, viewed without prepossession, necessitate or even unequivocally favor the contrary view. Those vitalists who maintain that material systems are incapable, without the aid of an entelechy, of developing the characteristics of life—and who even hold that fundamental physical laws like the second principle of energetics are evaded by organisms—must adduce evidence of a less doubtful kind in support of their thesis. The peculiarities which organisms exhibit appear to the reviewer to lead to precisely the contrary conclusions, and to indicate that stable and constantly acting physico-chemical systems may exhibit a degree of complication, both of composition and of behavior, to which literally no limits can be assigned.

Another mode of reasoning popular among vitalists, and equally fallacious from the physico-chemical standpoint, is that an entelechy can, without the performance of work, guide or coordinate toward a definite end processes which themselves require the performance of work. This view implies that in the organism molecular movement may be directed, retarded, or accelerated at the will of the entelechy. But in Newton's first law of motion it is surely made clear that any deviation in the move-

[2] Just why there is such repetition is rather a philosophical than a scientific question; but it seems probable that it is at bottom an expression of the homogeneity of the conditions of natural existence, space and time.

ment of a particle from a straight line, or any retardation or acceleration of its motion, involves work in precisely the same sense as does the initiation of the movement. Now it is evident that guidance or regulation of the sequence of events in any material system must involve one or other of these kinds of processes. In other words, it is physically impossible for any agency to modify the processes in any material system without modifying the energy-transfers in that system, and this can be done only by the introduction of compensating or reinforcing factors of some kind—*i. e.*, by altering the energy-content of the system—which is equivalent to the performance of work. One is forced to conclude that all such attempts at the solution of biological problems are based on fundamental misunderstandings. Dogmatism must be avoided in scientific criticism; nevertheless it seems to the reviewer that the following general considerations are incontrovertible, and that they are quite inconsistent with the type of vitalism represented by Driesch and Johnstone. First, the organism is a system whose development and continued existence are *dependent* on the rigid constancy of physico-chemical modes of operation; here, if anywhere in nature, stability of the internal or vital conditions is indispensable; otherwise it is inconceivable that the complex living system could persist, and maintain its characteristic activities and often delicate adjustment to the surroundings. Clearly the numerous and diverse processes whose integration constitutes life could not deviate far from a definite norm without fatal derangement of the whole mechanism. Second, the basis for this regularity is the regularity of physico-chemical processes in general. These, the more closely they are subjected to scientific scrutiny, appear the more definite and constant in their character: this conclusion is not—as many philosophical critics of scientific method maintain—an illusion resulting from the inherently classificatory nature of intellectual operations; it is simply a matter of observation and experimental verification. Repeat the conditions of a phenomenon and the phenomenon recurs. We find this to be equally the case in living organisms and in non-living systems; and it appears to be as true of psychical as of physical phenomena. The difficulty in dealing with organisms is to secure exact repetition of conditions, because organisms are in their nature complex, and complexity means a large number of factors which may vary. Regularity, in fact, may be said to be of the very essence of vital processes; special devices for securing regularity (*e. g.*, constancy of body-temperature, of the osmotic pressure and reaction of the tissue-media, etc.) are highly characteristic of organisms. It would seem that an entelechy disturbing this regularity, however intelligently, would be not only superfluous but detrimental. Moreover, we must always remember that unequivocal evidence for the existence of such an agency is quite lacking.

Thus there seems to be no valid reason to believe that organisms differ essentially from non-living systems as regards the conditions under which the processes underlying vitality take place. The *conditions* of natural existence and happening appear everywhere and at all times to be homogeneous, whatever existence itself may be. This conclusion seems unavoidable to the impartial observer of natural processes; the repetition so characteristic of nature is apparently an expression of this central fact. The flux-like character of natural existence, so insisted upon by Bergson and the other Heracleiteans, is to be admitted only in a highly qualified sense. Repetition and the existence of discontinuities and abrupt transitions are equally characteristic; and all of the evidence of physical science goes to show that a repetitious or atomistic construction lies at the very basis of things. So far from the intellect arbitrarily imposing a diagrammatic uniformity and repetition upon a nature which in reality is a progressive flux and never repeats itself—to the student of natural science it appears rather true that the conceptualizing characteristic of the reasoning process is itself one expression of this fundamental mode of natural occurrence—that it is, in fact, the derivative of a peculiarity which pervades na-

ture throughout. Such a view, if well established, would refute the contention that scientific methods, being intellectual in their character, necessarily involve a falsification; and would dispose of attempts to discredit physiological analysis on the ground that life transcends intellect and hence is properly to be investigated by other than scientific methods.

The attempt to find in organisms evidence of special agencies not operative in the rest of nature seems to the reviewer to show less and less promise of success as physico-chemical and physiological science advances. Thus the author's attempt to limit the applicability of the second law of energetics to the non-living part of nature is quite unjustified by the evidence which he presents. The interception and accumulation of a portion of the radiant energy received by the green plant, in the form of chemical compounds of high potential, is in no sense an infringement of the second law; as well might one hold that the partial transformation of radiant energy into potential energy of position, as seen, *e. g.*, in the accumulation of glaciers, is an instance of this kind. The partial transformation of energy at low potential into energy at high potential is in fact a frequent occurrence; thus the temperature of an electric arc far exceeds that of the furnace which generates the current; similarly the animal organism utilizes energy derived from oxidation of carbohydrates and proteins to build up compounds of much higher chemical potential, viz., the fats. If living organisms—systems which are specially characterized by utilizing chemical energy as the main source of their activity—exhibit such tendencies, there is in this fact nothing anomalous from the point of view of physical science. To say on the basis of this kind of evidence that "life appears as a tendency which is opposed to that which we see to be characteristic of inorganic processes" (page 314) is surely unwarranted from any point of view.

This review is not necessarily an attack on vitalism, but only on certain current forms of vitalism. It can scarcely be denied that there is something distinctive about life; but at the present advanced stage of physical science it seems futile to argue that the vital process is the expression of an agency which is absent from non-living material systems. Viewed temporarily or historically, the vital is seen to develop out of the non-vital; many of the steps in this process are still obscure; but with the progress of science it becomes more and more evident that the development is continuous in character. Hence, if we are to account for life, we must equally account for non-living nature. Now since nature exhibits itself as coherent throughout, we must conclude that in its inception[3] it held latent or potential within itself the possibility of life. This is not entirely an unbased speculation; even in the character of the chemical elements life is foreshadowed in a sense, as shown in Henderson's recent interesting book.[4] In a recent discussion,[5] in some respects related to the present, the reviewer has called attention to one implication of the scientific view of nature and the cosmic process. If we assume constancy of the elementary natural processes, and constancy in the modes of connection between them—as exact observation forces us to do—there seems no avoiding the conclusion that —given an undifferentiated universe at the outset—only one course of evolution can ever have been possible. Laplace long ago perceived this consequence of the mechanistic view of nature, and the inevitability of his conclusion has never been seriously disputed by scientific men. Nevertheless, this is a very strange result, and to many has seemed a *reductio ad absurdum* of the scientific view as applied to the whole of nature. The dilemma can be avoided only if we recognize that the question of ultimate origins is not, strictly speaking, a scientific question at all; and in saying this there is implied no disparagement of scientific method. As an object of scientific investigation nature has to

3 I do not use this term necessarily in a historical sense, but rather in the sense of ultimate origin of whatever kind,—which it may well be necessary to conceive as extra-temporal.

4 "The Fitness of the Environment," Macmillans, 1913.

5 Science, N. S., 1913, page 337.

be accepted as we find it; and why it exhibits certain apparently innate potentialities and modes of action which have caused it to evolve in a certain way is a question which really lies beyond the sphere of natural science. Such considerations, if they do not exactly remove the vitalistic dilemma, yet separate sharply the scientific problems which organisms present from the metaphysical questions to which the phenomena of life—more than any others —give rise. If we consider the organism simply as a system forming a part of external nature, we find no evidence that it possesses properties that may not eventually be satisfactorily analyzed by the methods of physico-chemical science; but we admit also that those peculiarities of ultimate constitution which have in the course of evolution led to the appearance of living beings in nature are such that we can not well deny the possibility or even legitimacy of applying a vitalistic or biocentric conception to the cosmic process considered as a whole.

Although disagreeing with the author's main contentions, the reviewer wishes to recognize the merits of the book as an interesting, enthusiastic and ingenious contribution to the literature of its subject. We have noted some errors in matters of biological detail, but these are not such as to affect the main argument. The brief account of certain physiological processes seems somewhat out of date; the account of the nerve impulse is unsatisfactory, and certainly few physiologists now hold that a muscle is a thermodynamic machine in the sense conceived by Engelmann; there is some evidence of unfamiliarity with biochemistry; the term "animo-acid" instead of amino-acid recurs a number of times, a mis-spelling perhaps appropriate to a book which is really a modern plea for animism.

Ralph S. Lillie

Clark University,
October 12, 1914

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH

On the invitation of the chairman of the executive committee of the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science, there was held at his house on the evening of November 28 a meeting of the executive committee and of some members of the subcommittees and of the general committee resident in or near Boston. There were present Mr. Charles W. Eliot, president of the association and chairman of the committee, Mr. E. C. Pickering, chairman of the executive committee, and Messrs. E. W. Brown, J. McKeen Cattell, W. T. Councilman, Charles R. Cross, Reid Hunt, Richard C. Maclaurin, A. A. Noyes, Theodore W. Richards, Elihu Thomson and Arthur G. Webster.

Plans for the work of the committee were discussed, and preliminary reports were presented from four of the subcommittees, as follows: Research funds, by Mr. Cross; research work in educational institutions, by Mr. Cattell; the selection and training of students for research, by Mr. Brown, and improved opportunities for research, by Mr. Richards.

In addition to the subcommittees whose membership has been announced, the committee on improved opportunities for research has been completed, and consists of Messrs. Theodore W. Richards, chairman, W. T. Councilman, Richard C. Maclaurin, T. H. Morgan and E. H. Moore. The subcommittee on the selection and training of students for research has also been formed, and consists of Messrs. E. W. Brown, chairman, Ross K. Harrison, George A. Hulett and W. Lindgren. Subcommittees have been authorized on research institutions, research in industrial laboratories, research under the national government, research on the Pacific coast and research in the south, but these committees have not yet been completely organized.

Reports from subcommittees will be presented at the meeting of the Committee of One Hundred, which will be held in the Houston Club, University of Pennsylvania, Philadelphia, at 2 o'clock, on the afternoon of December 28.

J. McKeen Cattell,
Secretary

THE PHILADELPHIA MEETING

THE local committee for the Philadelphia meeting of the American Association make the following announcements:

The hotels are either near the center of the city or in close proximity to the University of Pennsylvania. The headquarters of the association will be the Hotel Adelphia, 13th and Chestnut Streets, two blocks distant from both the Pennsylvania and Philadelphia & Reading Railroads. The Adelphia is the newest and most modern hotel in Philadelphia. Members are urged to make hotel reservations as early as possible.

The meetings of the association will be held at the University of Pennsylvania in West Philadelphia, ten minutes by trolley from the center of the city. The university can be reached by taking cars, route 13, on Walnut Street, one block south of the association headquarters, or cars route 11 or 34 on the subway surface lines on Market Street, one block north. Persons arriving on the Pennsylvania Railroad and desiring to go directly to the University of Pennsylvania or to hotels near the university should get off at West Philadelphia Station, six minutes' walk to the university.

The Houston Club, Spruce Street near 34th Street, has been designated as the association headquarters at the University of Pennsylvania. This building is the geographical center of the university and all meetings of the association will be held in university buildings within a radius of two blocks from this point. The privileges of the club are extended to all of the members of the association and affiliated societies. Mail may be addressed here.

The general meeting of the association will be held in Weightman Hall, gymnasium of the University of Pennsylvania, 33d and Spruce Streets, on Monday evening, December 28, at 8 o'clock.

Luncheon will be served in the gymnasium, daily at one o'clock, during the convention, and all in attendance are cordially invited.

The provost of the University of Pennsylvania will give a reception to the members of the association in the university museum immediately after the address of President Wilson.

Placards of the university campus will indicate meeting places of the various sections.

The Geological and Paleontological Society will hold its meeting at the Academy of Natural Sciences, 19th and Race Streets.

SCIENTIFIC NOTES AND NEWS

THE De Morgan medal of the London Mathematical Society was presented at its annual meeting to Sir Joseph Larmor in recognition of his researches in mathematical physics.

PROFESSOR H. F. NEWALL has been elected president of the Cambridge Philosophical Society. The vice-presidents are Dr. E. W. Barnes, Dr. A. C. Seward and Dr. A. E. Shipley.

PROFESSOR WILHELM ERB, the distinguished neurologist of Heidelberg, has celebrated the fiftieth anniversary of his doctorate.

PRESIDENT CHARLES RICHARD VAN HISE, of the University of Wisconsin, will be the convocation orator at the University of Chicago.

PROFESSOR ROBERT M. YERKES, who on the invitation of the authorities of the German Anthropoid Station at Orotava, Tenerife, had planned to spend the greater part of the year 1915 at the station in an experimental study of the chimpanzee and orang-outang, has been forced to abandon his plan because of the condition of war in Europe. He will instead conduct his investigations during the spring and summer of 1915 at Montecito, California, in conjunction with Dr. G. V. Hamilton, in the latter's private laboratory. From February to October, 1915, Professor Yerkes may be addressed at Santa Barbara, California.

PROFESSOR J. C. BOSE, of Calcutta, known for his work in plant physiology, is in this country. He is to be in the east until January 11, on which date he addresses the New York Academy of Sciences, and before which time he will speak at various universities and to scientific bodies. During the latter part of

January he is arranging a trip to several middle western universities.

Dr. Paul V. Neugebauer has been appointed observer in the astronomical institute of the University of Berlin in succession to Professor P. Lehmann.

The Harvard corporation has appointed Arthur W. Carpenter, of Boston, to the Central American fellowship in archeology, with an income of $600 a year.

The *Journal of the American Medical Association* states that the salaries of Dr. Haven Emerson, sanitary superintendent, and Dr. William H. Park, general director of laboratories in the New York Health Department, have been increased to $6,000 a year on the condition that they give their full time to the work, relinquishing private practise and their work in Columbia University.

Dr. Albert Calmette, the eminent pathologist, director of the Pasteur Institute at Lille, who has been acting as one of the chiefs of the medical service of the French army, has been missing for some time. It is now reported that he is a prisoner of war at Münster. Dr. Calmette is a brother of the late editor of the *Figaro,* Gaston Calmette.

Dr. F. F. Buckhemer, third incumbent of the exchange curatorship in paleontology at Columbia, is a prisoner of war in Brest, France, and Dr. Hülsenteck, fourth incumbent, is a prisoner of war in Gibraltar.

The Iron Cross has been awarded to Dr. Karl Thomas, of Professor Rubner's laboratory in Berlin, who was in charge of a field hospital near Mons, for courageous action during the retreat.

Dr. Felix von Luschan, director of the Berlin Museum of Ethnology and professor in the university, lectured before the Germanistic Society in New York on December 2, on "Peoples of West Asia," and at Columbia University on December 9 on "Excavations in Asia Minor."

Dr. Henry S. Graves, chief forester of the United States, lectured before the Washington Academy of Sciences on December 3, on "The Place of Forestry in the Natural Sciences."

Professor Lafayette B. Mendel, of Yale University, will give a course of lectures under the Herter foundation, at the University and Bellevue Hospital Medical College, on December 10, 11, 14 and 15. The subject of the lectures, which will be given at four o'clock in the afternoon, is "Aspects of the Physiology and Pathology of Growth."

Mr. P. Macleod Yearsley lectured upon the "Classification of the Deaf Child for Educational Purposes" at a meeting of the Child Study Society at the Royal Sanitary Institute, London, on November 5.

We learn from the *Cornell Alumni Weekly* of the death of Daniel Elmer Salmon, the first chief of the U. S. Bureau of Animal Industry, at Butte, Mont. He was born at Mount Olive, Morris county, N. J., in 1850, and entered Cornell University when it opened in 1868. He became interested in the study of veterinary medicine after becoming acquainted with Dr. James Law, who had just come to Cornell from Scotland. After practising for several years, Dr. Salmon was from 1878 till 1884 connected with the U. S. Department of Agriculture as an investigator of animal diseases. The Bureau of Animal Industry was established in 1884, and Dr. Salmon was appointed chief of that bureau, holding the office till 1906.

Dr. George L. Manning, professor of physics at Robert College in Constantinople, has died in Florence, Italy, while on his way home, after a recent illness. Dr. Manning was 50 years old. He was graduated from the Massachusetts Institute of Technology and had taught at Stevens Institute of Technology and at Cornell University.

The Reverend Dr. Addison Ballard, at one time professor of science and mathematics at Marietta College and Ohio University, and later professor of philosophy at Lafayette College and at New York University, has died at the age of ninety-two years.

DR. EWALD FLÜGEL, of the chair of English philology at Stanford University, died at his home in Palo Alto on the evening of November 14, in the fifty-first year of his age. He had been connected with the university from its beginning in 1892, coming from the University of Leipzig.

DR. GIOVAN BATTISTA GUCCIA, professor of higher mathematics in the University of Palermo, died in that city on October 29. Professor Guccia was the founder in 1884 of the Circolo Matematico di Palermo and editor of its *Rendiconti.*

DR. CHARLES BARRETT LOCKWOOD, a distinguished English surgeon, well known as a teacher and as a writer on surgery, has died at the age of fifty-six years from septicemia contracted in the course of an operation.

DR. HEINRICH BURKHARDT, professor of mathematics in the Technical Institute of Munich, has died at the age of fifty-three years.

DR. EMIL ALFRED WEBER, emeritus professor of philosophy at Strassburg, has died at the age of seventy-nine years.

LIEUT.-COLONEL SIR DAVIS PRAIN, director of the Kew Botanical Gardens, has lost his only son, Lieut. T. Prain, who has been killed in action.

DR. F. FELIX HAHN, assistant curator in the Königliche Hof Museum, Stuttgart, and lieutenant in the Bavarian artillery fell before Nancy on September 8. On receiving his doctorate from Munich in 1911, he came to the paleontological department of Columbia University as the first exchange assistant and curator in paleontology. During his year in this country he did some detailed work on the grapholites leading to the publication of his paper "On the Dictyonema Fauna of Navy Island, New Brunswick." Another contribution was on "The Form of Salt Deposits." Among his papers in German may be mentioned: "Ergebnisse neuer Spezialforschungen in den Alpen," "Die neuere regional geologische Spezialliteratur der bayerischen und nordtiroler Alpen," "Zür Geologie der Berge des oberen Saalachtales," "E. O. Ulrichs 'Revision der Palaeozoischen Systeme'—ein Merkstein der Stratigraphie als Wissenschaft?," "Untermeerische Gleitungen bei Trenton Falls (Nord Amerika), und ihr Verhältniss zu Ahnlichen Störungsbildern." This last paper is one of the most important contributions to structural geology made in this country in the last few years.

THE Carnegie Museum has secured, through Professor C. H. Eigenmann, the pamphlet library of the late Dr. Albert Günther, long headkeeper of the British Museum of Natural History, justly regarded in his time as the most eminent ichthyologist and herpetologist of Great Britain. The collection comprises almost all the literature relating to fishes and reptiles printed in the periodicals and journals of learned societies during the eighteenth and nineteenth centuries.

THE Georgia State Sanitarium at Milledgeville has been selected by the United States government as a station for experimental work in pellagra cases. The patients will be segregated and kept under special treatment and diet, the work being done under the charge of two experts of the United States Public Health Service.

A SERIES of addresses on subjects connected with the European war is announced at the University of Chicago. They include: "Racial Traits Underlying the War," William I. Thomas, professor of sociology, December 3; "The Balkan Question," Ferdinand Schevill, professor of modern history, January 7; "Russian and Asiatic Issues Involved," Samuel N. Harper, assistant professor of Russian language and institutions, January 14; "The Effects of the War on Banking and Credit," Professor Andrew C. McLaughlin, February 4; "The Ethics of Nations," James Hayden Tufts, head of the department of philosophy, February 11; "The Rights and Duties of the United States as a Neutral Nation," Charles Cheney Hye, professor of law, Northwestern University, February 18; "Geographical and Economic Influences," J. Paul Goode, associate professor of geography, February 25;

"The Effects of the War on Economic Conditions," Chester W. Wright, associate professor of political economy, March 4.

The Rice Institute announces its first series of unversity extension lectures to be given on the afternoons of Mondays, Wednesdays and Fridays. The scientific lectures, given on Wednesdays, are as follows:

Electricity, illustrated by numerous experiments, a course of six lectures by Harold Albert Wilson, professor of physics.

The Geology of Texas, a course of three lectures by Edwin Theodore Dumble, consulting geologist of the Southern Pacific Company.

Applications of Chemistry to Industry and Commerce, a course of three lectures by Arthur Romaine Hitch, instructor in chemistry.

As an answer to the impression which seems to exist, that all the public lands of any value have long ago been taken up, Secretary Lane, in an advance statement from his annual report, calls attention to the fact that since March 4, 1913, settlers have made entry on nearly 20,000,000 acres of public lands—an area equal to that of Connecticut, Massachusetts, New Hampshire and New Jersey combined. During the same period practically as much more coal and other mineral land of the west has been examined in detail in 40-acre tracts by the Geological Survey, and most of it has been thrown open to settlement or purchase. Some of these lands, such as those which include workable deposits of phosphate or oil, are still withdrawn pending suitable legislation for their disposal or use. Another important activity in public-land classification to which the secretary calls attention is the designation of lands for entry as "enlarged" or 320-acre homesteads. Designations under this law approved by him, cover 33,453,056 acres. The extract from the secretary's report contains a series of maps of twelve public-land states showing in graphic form (1) the areas withdrawn from entry in these states between March, 1913, and July, 1914, (2) the areas restored to entry, (3) the designations under the enlarged-homestead law, and (4) land taken up by settlers. Thus, for example, the map of Montana shows the total area for the state, 93,000,000 acres; lands withdrawn from entry, 67,741 acres; lands restored to entry after examination, 3,171,558 acres; lands designated under the enlarged-homestead law, 11,022,854; acres and lands entered by settlers, 7,417,291 acres. The other states in which public-land activities have been large and which are discussed by the secretary are Utah, Wyoming, Colorado, New Mexico, Idaho, Washington, Oregon, North Dakota, Arizona, California and Nevada.

Attention is called by *The Observatory* to the fact that at the congress of the representatives of the national ephemerides held in Paris in 1911 a scheme of cooperation between the various countries was planned, so as to assure in the future a greater production of useful work and to avoid a superfluous repetition of the computations. This end was to be attained by a plan of exchange and division of work, although each Almanack was to retain its own distinctive features. The ephemerides for 1916 mark the inauguration of this arrangement. The Nautical Almanack Office has been supplied from abroad with the following: The ephemeris of Mercury from Berlin. The apparent places of polar stars from Paris. The apparent places of stars from Berlin, San Fernando and Turin. Details of eclipses and elements of occultations from Washington. The positions of the satellites of Mars and of Jupiter's fifth satellite from Washington; of Jupiter's four principal satellites from Paris; of Saturn's satellites and ring from Berlin; of the satellites of Uranus and Neptune from Washington. Physical ephemerides of the sun, moon, Mercury, Venus, Mars and Jupiter from Washington. The Nautical Almanack Office has in its turn supplied, under this arrangement, the greater part of the Greenwich ephemerides of the sun, moon and planets. In the table of the mean places of stars the magnitudes are taken from the Revised Harvard Photometry, instead of, as previously, from Newcomb's Fundamental Catalogue. The spectral types, as given in the Revised Harvard Photometry, are now also added. From 1916 onwards, the fundamental meridian adopted by the *Connaissance des Temps* will be the meridian of Greenwich.

THE annual meeting of the American Anthropological Association will be held in Philadelphia from December 28 to 31, in affiliation with Section H of the American Association for the Advancement of Science and the American Folk-Lore Society. Titles for the joint program should be sent immediately to Professor George Grant MacCurdy, secretary, Yale University Museum, New Haven, Conn.

UNIVERSITY AND EDUCATIONAL NEWS

THE board of regents of the University of Michigan has revised the faculty salary schedule of the literary department and the academic divisions of the engineering department. The revised and the original scales follow: Instructors, $1,000–$1,600, formerly $900–$1,400; assistant professors, $1,700–$2,000, formerly $1,600–$1,800; junior professors, $2,100–$2,400, formerly $2,000–$2,200; professors, $2,500–$4,000, formerly $2,500–$3,500. The revised scale affects 200 teachers, and increases the year's budget by approximately $40,000.

CONTRACTS have been let for the construction of Ida Noyes Hall, the building which is to serve the women students of the University of Chicago as Bartlett Gymnasium and the Reynolds Club, provide for the physical culture and social needs of the men. This building, a gift of Mr. La Verne Noyes as a memorial to his wife, will be completed in January, 1916, at a cost of over $450,000.

DR. ROGER I. LEE, of Boston, has been elected to the chair of hygiene recently established at Harvard University.

DR. HOWARD THOMAS KARSNER, assistant professor of pathology in the Harvard Medical School, has been appointed professor of pathology in the school of medicine of Western Reserve University.

DR. JOHN PENTLAND MAHAFFY, known for his work on Greek history, literature and social life, has been appointed provost of Trinity College, Dublin.

DR. ALDO CASTELLANI, director of the clinic for tropical diseases, Colombo, Ceylon, has been appointed by the Italian government professor of tropical medicine in the University of Naples, and the director of the royal clinic for tropical diseases in the same city.

DISCUSSION AND CORRESPONDENCE

A PECULIAR BEHAVIOR OF CUMULUS CLOUDS OVER THE ILLINOIS RIVER VALLEY

AT noon on a bright day in mid-August, 1914, the writer noticed over the valley of the Illinois River in Schuyler County, Illinois, a phenomenon which he deems worthy of record. The day was hot, with a brisk breeze from the west, and clear except for light cumulus clouds, uniformly and fairly closely spaced,

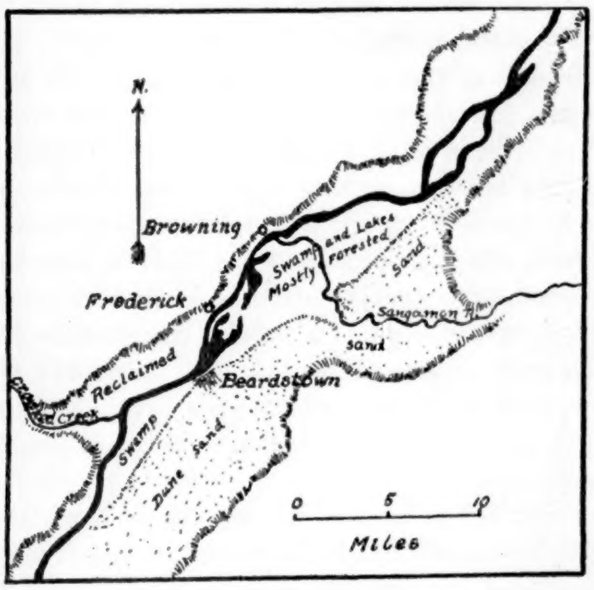

FIG. 1. Sketch of the portion of the Illinois River Valley along which the phenomenon here described was observed. Clear sky lay over the swampy and forested portion of the valley northeast of Beardstown while over the uplands and the reclaimed bottomlands cumulus clouds were observed. From the point of observation it could not be determined whether the clouds began again at the edge of the dune sand or at the eastern bluff.

moving rather rapidly with the wind. During a stop for lunch on the crest of the western bluff-border of the valley between Frederick and Browning (Fig. 1) attention was drawn to the movement of the cumulus clouds overhead. As a matter of curiosity a particular

cloud was selected with the idea of noting its changes of shape and something of its rate of movement. The cloud selected advanced to a point almost exactly overhead, then began to melt away. In a space of less than five minutes it had entirely disappeared. Another and yet another did the same. Finally, an unusually large cloud was selected; but this, too, disappeared on reaching approximately the same point. All advanced in orderly procession from the west till, overhead, they reached a lane of clear sky, then melted away.

This lane of clear sky, several miles wide, stretched away northeastward to the horizon, following very closely the course of the valley of the Illinois River, and southwestward over the river valley for 4 or 5 miles, after which it gave place to the usual cumulus clouds. To the east of the valley the cumulus clouds appeared once more and continued to the horizon. These relations were observed to persist throughout the greater part of the afternoon.

A possible explanation of the phenomenon which suggested itself at the time is here recorded as a working hypothesis to be considered in connection with similar occurrences which may from time to time be described. To make this explanation clear, a brief description of the geography of the region is necessary.

The valley of the Illinois River here is a flat-bottomed trough from 4 to 10 miles wide, bordered by relatively sharp bluffs, and is sunk some 200 feet below the general upland level of this part of the state. The upland is mainly cultivated farmland, much of it at this time of year bare after the wheat, hay and oats harvest. The river bottom, on the other hand, east of the point of observation and to the northeast as far as could be seen, is largely either swampy, with several lakes, or forest-covered. Four or five miles to the southwest, however, in the neighborhood of Beardstown, a considerable portion of the river bottom has been reclaimed and is given over to agriculture.

The explanation suggested is that over the upland farms numerous convection currents gave rise to cumulus clouds, while over the swamp and forest lands of the river bottom convection currents were subordinate or, perhaps, absent; that consequently, this cooler belt over the bottomlands not only failed to produce new cumulus clouds but also tended to become the channel of descent for some of the air which had been rising by convection from the surrounding hotter lands. On reaching such a belt of descending air, the clouds should be expected to melt away as they were drawn downward and to leave a zone of clear sky over the area of descending air. The width of the valley—4 to 10 miles—as compared with the height of the clouds—probably about one mile—should give ample opportunity for differences in heating to become effective in modifying the air currents and therefore the behavior of the clouds.

The presence of the cumulus clouds over the reclaimed parts of the bottomlands near Beardstown is thought to be significant in connection with the above explanation, since these would doubtless be heated nearly as effectively as the upland.

Other possible explanations of the phenomenon might be suggested, but it seems idle to speculate further until more observations of a similar nature have been made.

John L. Rich

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CYANIDE OF POTASSIUM IN TREES

To the Editor of Science: I note an interesting contribution to Science in the issue of October 9, on the subject of cyanide of potassium taken up by trees when put into holes in the same. I wish to report that this chemical is the chief basis of treatment by a firm in Allentown, Pa., doing an extensive business in some of the Eastern States, claiming to render trees immune from attacks by all insects and diseases, and also to fertilize them. The process was originated by a man named Kleckner, and is now continued by a company called the Fertilizing Scale Company, of Allentown, Pa. Their theory is that a tree can be given medicine, as well as food, by placing the same in capsules and fastening these in incisions under the bark. While the chief insect

poison is cyanide of potassium, yet they use chlorate of potash and sulfate of iron "to give the trees chlorine, sulfur, iron and potash." They make wonderful claims for the destruction of the scale and invigoration of trees, and commenced by charging fifty cents per tree for the so-called "vaccination." The price is now reduced to fifteen cents, but they are taking thousands of dollars from the confiding public.

The important scientific point is that I have examined hundreds of trees treated by them, and have in some instances found no evidences that scale insects were ever present, while in others I have found the San José scale alive on the trees some time after treatment. What is much worse is that I have found it is true that some one or more of these chemicals is evidently taken up in the sap of the tree, and that to a considerable extent. While the material was placed under the bark about three feet from the ground, it blackened the cambium layer as high as I could reach and remove the bark, and started blight or death of tissue at the place where inserted. I have the names of scores of persons whose trees or orchards were finally killed by this treatment. One man, whose name and address I can give, thought that it benefited his trees, and had it applied the second year, and the trees then died quickly. He is now disgusted with the treatment.

In company with Professor I. C. Williams, Deputy Forestry Commissioner of Pennsylvania, I visited an orchard in Lebanon County that had been treated a few weeks previously. The San José scale was found alive on the trees, but blight or death of tissue had commenced at the place of treatment and had worked downward slightly and upward considerably, and in fact, as high as one could reach. During the present week I have learned of another orchard, in Cumberland County, Pennsylvania, that was blighted and destroyed by the cyanide treatment. Therefore, while it is evident that some chemicals may be taken up in the trees and may even destroy some insects, it is further evident that they may be injurious to the trees, and should be applied with great care and only after considerable experimentation, and should be recommended by scientists only after great deliberation. I shall send to interested persons printed articles on this subject from the office of the State Zoologist, Harrisburg, giving names and addresses of persons whose trees have been killed by the cyanide "vaccination," as the fakirs call it. These may be published.

H. A. SURFACE,
State Zoologist

DEPARTMENT OF AGRICULTURE,
HARRISBURG, PA.

QUOTATIONS

RESEARCH AND TEACHING

THERE are at least three different conceptions of a university. To some men it means a group of technical schools which prepare for many distinct vocations; a place of universal study, as contrasted with one that pursues a single line only. To some men it means a place which is widely known for its teachers of science and literature and the discoveries that they are making; a school of universal reputation, as distinct from one whose fame is merely local. Still others think of it as a place where students can get wide range of knowledge and fit themselves for their duties as citizens of a self-governing community; a school with ideals of universal culture, rather than of narrow specialization.

The German university emphasizes the first and second of these conceptions; the French, the first and third; the English, the second and third. The American college in its early days devoted itself almost exclusively to the third. In attempting to become universities instead of colleges, our schools of higher learning in America have in recent years tried to combine all three aims; but often under such adverse conditions or with such inadequate resources that they have failed of actually attaining any one of them.

Under these circumstances a widespread belief has arisen that the three things should be separated rather than combined; that we

ought to have country colleges to give the students general culture, city technical schools to train them for their several callings, and research foundations, apart from college or technical school, to promote scientific discovery and other forms of intellectual achievement, by relieving the man who does creative work from the necessity of teaching.

Let us first examine the arguments of those who say that research ought to be separated from teaching.

The qualities of the investigator and the qualities of the teacher are quite different. A man may be good in one of these lines and bad in another. If investigators and teachers are associated in a university under the common title of professor, the tendency is to require every man who seeks a position at the head of his department to do something in both lines. The college is so largely dependent upon teaching for its revenue that it can not make any adequate payment to the investigator who does not teach. It is at the same time so dependent upon investigations for its outside reputation that it can not give the highest recognition and promotion to the teacher who does not investigate. Under these circumstances we get no proper division of labor. The man who ought to be making discoveries is compelled to waste his time in teaching students who can not appreciate and understand him. The man who ought to be teaching classes inspiringly and effectively feels himself compelled to do second-rate work of investigation which is of no inspiration to him or to anybody else. What is true of science is true of letters. The man who should be a creative author is made to do bad teaching. The man who should be an effective teacher is encouraged to write bad prose or worse poetry. To secure the advantages which the community can derive from proper division of labor—advantages which the community secures in every line of productive work except science and letters—we ought to have foundations which, by relieving our universities of the responsibility for progress in science and letters, will enable them to spend their money in paying adequate salaries to men who can teach. Such are the views of those who argue for the extrusion of research from our universities.

These arguments are plausible; to a certain extent, they are sound. Foundations to promote scientific discovery or literary production are admirable things. There are some men who can work more effectively without a university connection than with one; and it is most important to provide such men with opportunities. But if this idea were carried to the extreme, and it were understood that the universities were places for teaching and not for investigation, the result would certainly be bad for the universities themselves, and would probably be bad for the progress of science and letters as a whole.

For while it is true that the work of the investigator and the work of the teacher are different, it is not true that they are habitually separate or antagonistic. There are some productive scholars that can not teach at all; but the majority of them can teach remarkably well if you give them the opportunity to do it in the right way. On this point I may be permitted to quote a paragraph from my report of eight years ago:

> We are not dealing with an ordinary case of division of labor. The chief argument for division of labor is that it makes each man more expert and more efficient in his own field of work. In university work, however, the man who tries to investigate without teaching is apt to become sterile, while the man who attempts to teach without investigating becomes a worse teacher instead of a better one. We want the opportunities for research and investigation distributed as widely as possible throughout the teaching force and the student body. We want to impress upon every man that teaching and discovery are both done at their best when done in combination. Not that every man should be compelled to lecture to classes, whether he is able to do so or not. There is a great deal of valuable teaching which is not done in the class-room, or even in the laboratory. There are some men who teach best by their writings, their conversations, their intelligent suggestions for the work of others; but they should understand that they are part of the teaching force, and are simply doing their teaching in a dif-

ferent way from other men. Instead of setting such a man apart as a research professor, we should let him understand that withdrawal from the lecture room and relief from the duties of supervising elementary students carry with them a larger obligation to publish as fully as possible the results of all discoveries, to organize departments intelligently, to train up young men who can teach; and to make liberal room for such men, instead of trying to get in their way when their work becomes popular.

The routine work of teaching, if done under favorable conditions, is often a positive help to a scientific or literary man in keeping his nerves steady. Very few scholars, however productive, can write well all the time. Very few investigators, however well qualified, can make a continuous series of discoveries. If a man has nothing to occupy him in his less fertile intervals he will be tempted either to remain wholly idle or to publish second-rate books and pseudo-discoveries. A teaching position enables him to fill his time with work sufficiently close to his lines of productive activity to be stimulating and yet with enough of routine in it to make it healthful. And to most men this combination of teaching with research gives positive enjoyment of a high order. We may well remember the words of Lord Kelvin in connection with his receipt of the degree of Doctor of Laws from Yale in 1902:

> There is one point on which I specially desire to speak. College professors should be permitted and given the means to do research work. On this matter of research I feel deeply. At the same time I do not believe it wise to have a research laboratory without teaching. It is a pleasure for a professor to meet students and to tell them what he can, and a greater pleasure if he can make them understand, and the greatest pleasure if he can widen the borders of their knowledge. To combine research work with teaching is most valuable both for student and teacher.

This is not intended as an argument against the establishment of institutions for research. There is room outside of the universities for all the endowments which we now have for productive work in science and letters, and for many more. There is as much difference of temperament among investigators as there is among men of any other kind. Some do better research work when they are relieved of the necessity of teaching. For these we should have independent foundations. Others, whom I believe to be a decided majority, do better research work in connection with university positions. I regard it as a most fortunate circumstance that we are able to make provision for men of both kinds.

Nor is this intended as an argument against appointing men to professorial positions who are inspiring teachers rather than productive scholars. Our colleges need all the good teachers that we now have, whether they are productive scholars or not. But with a large number of men good teaching and productive scholarship ought to be conjoined; and it would be most unfortunate for such men themselves, for our universities, and for America's progress in science and letters, if we attempted to dissociate things that so generally belong together.—From the annual report of President Arthur T. Hadley, Yale University.

SCIENTIFIC BOOKS

List of Prime Numbers from 1 to 10,006,721. By DERRICK NORMAN LEHMER. Carnegie Institution of Washington, Publication No. 165, 1914. Pp. xv + 133.

By the publication of his factor table for the first ten million natural numbers (Publication 105, Carnegie Institution of Washington, 1909) Professor Lehmer offered to the public a monumental work which will probably remain a model of its kind for centuries in view of its accuracy. The present work is based upon this factor table and was prepared with equal care. The pages are of the same size in these two publications, but the present volume is not quite one third as large as its predecessor.

Since the natural numbers are fundamental in many mathematical theories, it is not infrequently useful to know whether a given number is prime. The direct determination of this property is generally very laborious when the number is large. Hence a reliable table may save an enormous amount of labor.

On the other hand, such a table is very useful as a check in the development of theorems relating to prime numbers. Mathematical interest along this line has been greatly stimulated in recent years by the publication of the elegant work, in two volumes, entitled "Handbuch der Lehre von der Verteilung der Prinzahlen" by E. Landau, of Göttingen, Germany.

The prime numbers contained in the present volume can be found by means of the given factor table, but it is much easier to use the present table in case the only question under consideration is whether a given large number, within the limits of this table, is prime or composite. Each page contains 100 rows and 50 columns of numbers, and hence there are 5,000 different prime numbers on a page. It is therefore very easy to determine, by means of this table, the number of prime numbers lying between any two numbers within the limits of the table.

The Introduction covers fifteen pages and deals with various questions relating to prime numbers. It includes a table exhibiting the actual numbers of prime numbers at intervals of 50,000 up to 10,000,000, and comparing them with the approximate numbers of these primes according to the formulas of Riemann, Tchebycheff (Čebyšëv) and Legendre. It is somewhat surprising to find that the Introduction contains evidences of carelessness while the body of the work seems to have been prepared with the greatest care.

In fact, at least three inaccuracies appear on the first page of the Introduction. Line twenty begins with the word "infinite" instead of "finite." In line thirty-seven of the first column it is stated that Eratosthenes was a contemporary of Euclid. As a matter of fact it is not known whether Euclid was still living when Eratosthenes was born. We know very little about the life of Euclid, and it is distinctly stated in Günther's "Geschichte der Mathematik," 1908, page 83, that we do not know whether Euclid and Eratosthenes were contemporaries. In line sixteen of the second column of the first page the symbol 2^{2n} should be replaced by $2^2{}_n$.

In referring to these inaccuracies in the Introduction it is not implied that they affect seriously the value of the book. On the contrary, we desire to emphasize the fact that the table is not to be judged by its Introduction. Professor Lehmer realizes very keenly the great importance of accuracy in listed results, and he has made a careful study of methods which tend to insure the greatest possible accuracy. In view of the enormous amount of labor involved in testing the accuracy of such tables sufficiently to pass reliable judgment, the reviewer bases his confidence in the accuracy of the present table on the methods used by the author, and not on his own direct observations.

In closing we may refer briefly to the following interesting sentence which appears on page x of the Introduction: "It is hardly likely, indeed, that any theorem of importance in the Theory of Numbers was ever discovered which was not found in the first place by observation of listed results." Professor Lehmer's comprehensive knowledge of the developments in Number Theory gives great weight to this striking emphasis on the importance of listed results. To the reviewer the quotation appears to emphasize too much the usefulness of the method under consideration, especially as regards the developments in the theory of algebraic numbers.

G. A. Miller

University of Illinois

Natural Sines to Every Second of Arc, and Eight Places of Decimals. Computed by E. Gifford from Rheticus. Manchester. Printed by Abel Heywood & Son, 47 to 61 Lever Street. 1914. Pp. 543.

Among the extensive trigonometric tables which were calculated during the sixteenth century those of Rheticus occupy the most prominent place. That an immense amount of labor, devotion and perseverance was involved in the preparation of such tables may be seen from the fact that Rheticus employed computers for twelve years at his own expense.[1] His "Opus Palatinum," published posthu-

[1] Braunmühl, "Vorlesungen über Geschichte der Trigonometrie," Vol. 1, 1900, p. 212.

mously in 1596, contained tables to ten decimal places of the natural trigonometric functions at intervals of ten seconds. This was surpassed in 1613 by the tables in the "Thesaurus Mathematicus," which were based by Pitiscus upon unpublished tables computed by Rheticus, and gave the values of the natural functions to fifteen decimal places.

Soon after the appearance of these extensive tables the public began to realize the great advantages of logarithmic computation. The "Trigonometria Britannica" by Briggs and the "Trigonometria artificialis" by Vlacq appeared in 1633, and served as sources for numerous briefer logarithmic tables of trigonometric functions. For about three hundred years it appeared as if the greater part of the labor put on the natural function tables had been wasted. In recent years calculating machines have to a considerable extent replaced logarithmic tables, and have brought the natural function tables into more prominent use; thus furnishing another instance of unforeseen usefulness of mathematical lore.

In 1897 W. Jordan published a table of the natural trigonometric functions to seven decimal places, basing his work upon the "Opus Palatinum." To-day we have before us this work by E. Gifford based on the tables of Rheticus and aiming to facilitate the use of these tables by computing the values of the natural functions from second to second by interpolation. In view of the recent refinement in observation seven place tables do not always secure sufficient accuracy. Hence the present tables are computed to eight decimals.

One of the most important elements in such tables is accuracy. As the main tables of Rheticus have been improved by successive computers it would appear that serious inaccuracies in such tables as the present could easily be avoided. The author of the present table does not inform us as regards his precautionary measures except that "the sines to 1″ were interpolated by the Thomas calculating machine from Rheticus's figures for 10″, each being copied to 10 places and obvious mistakes corrected so that the differences run in descending series." It is a somewhat curious fact that at the top of the first page of the table we find cosine 1 in place of cosine 90°.

G. A. MILLER

UNIVERSITY OF ILLINOIS

Zur Frage der Entstehung maligner Tumoren. By TH. BOVERI. Jena, Gustav Fischer. 1914. 64 pages.

The eminent position held by Professor Boveri in the field of cytology, if for no other reason, entitles him to a careful hearing in any allied field of research, and the present highly suggestive hypothesis as to the origin of malignant tumors is by no means inappropriate from him since the tumor problems in their last analysis are cell problems. The medical man will probably pay little attention to this theory because it offers no practical solution of the cancer problems. Medical men interested in the theories as to the causation of cancer, and especially those who follow von Hansemann, however, will find in Boveri's hypothesis a most interesting and suggestive *modus operandi* for their favorite theory.

In any hypothesis of cancer origin the difficulty to be overcome is the phenomenon of unrestricted cell division of the malignant cancer cells. This is the crux of the whole matter and it is here that every current hypothesis of cancer origin falls down, but in Boveri's hypothesis this point is met.

The theory rests upon a number of assumptions, some of which are supported by experimental evidence, some are purely conjectural. We may briefly summarize these assumptions as follows: First, the chromosomes are qualitatively different and a certain number and assortment of them are necessary for normal balanced activities of the cell; second, abnormal mitosis in the form of multipolar spindle formation, leads to unequal distribution of the chromosomes in the resulting cells; third, lost chromosomes are never replaced and the abnormal cell, if it divides further, must give rise to similar abnormal cells; fourth, such an abnormal cell with its chromosome complex has a different set of interactions with the surrounding tissues

and with the organism as a whole, than does the normal tissue cell (or, as an alternative assumption, there may be in the nucleus special division-forcing or division-preventing chromosomes); fifth, a malignant cancer cell is one having an abnormal chromosome complex which continually reacts to a division stimulus from the surroundings, or in which the division-preventing chromosomes are absent, or in which possible division-forcing chromosomes are present in multiple number; sixth, the malignant tumor always arises from one single cell; seventh, this primordial cancer cell arises by abnormal division of an otherwise normal tissue cell and may start from any one of a large number of different causes.

Of these assumptions the first, second and third are supported by experimental evidence; the fourth may be accepted as a corollary from the experimental evidence. The remainder, while based upon the experimental evidence, are not supported by direct evidence.

The experimental evidence is based upon the well-known work by Boveri himself on dispermic eggs of the sea-urchin in which, through multipolar spindles, the chromosomes are irregularly distributed in the four resulting cells. Such four-cell stages, submitted to the action of Herbst's decalcified sea water, separate and develop on immersion in normal sea water. The variety of irregular and abnormal larvæ resulting from this treatment indicate the qualitative differences of the chromosomes and the need of a balanced chromosome complex. Further experimental evidence of the qualitative difference of chromosomes is furnished by the modern work in cytology and in experimental breeding, especially in connection with the sex chromosome. Observations and experiment have led to the general acceptance of the theory of the individuality of the chromosomes and of the conclusion that a chromosome, once lost, can not be replaced or regenerated from other chromosomes.

That single chromosomes of tissue cells of vertebrates represent different activities in the cell is the basic assumption in Boveri's cancer theory. In his earlier experimental work he showed that some chromosomes might be absent without causing ill effects on the further activity of the cell, while the loss of others would be shown by pathological effects on future structures and activities. If the same principle holds for tissue cells, an abnormal mitosis might give rise to cells with an unequal distribution of chromosomes, and such cells might have a chromosome complex which would permit the ordinary, controlled activities of the cells of that particular tissue, and the result would be relatively harmless; or, one of such cells might have an abnormal chromosome complex in which the controlling factors of division are either absent or overbalanced and unlimited growth and division would result. Not every abnormal mitosis in normal tissue cells would thus lead to tumor formation but only such as have the abnormal chromosome complex which represents an uncontrolled growth and division energy. His theory thus demands that a given cancer arises from one original cancer-producing cell which transmits its chromosome complex and its abnormal peculiarities to all of its daughter cells and so gives to the cancer, as a whole, its peculiar cellular characteristics. The theory has nothing to do with abnormal mitoses in the cancer cells themselves; such abnormal mitoses tend to break up the peculiar and malignant chromosome complex and to render the progeny of such cells harmless. In a sense therefore, abnormal mitoses in cancer might be indicative of spontaneous healing, although by the theory it is equally possible that a new and more malignant type of cancer might be started.

The cause of a malignant tumor, according to this hypothesis, thus may be anything which induces abnormal mitoses; for example, chronic irritation sets up regenerative processes and continues to act during the mitotic processes involved in this regeneration. One or several mitotic figures might be broken up by such irritation thus giving rise to unequal distribution of chromosomes in the resulting cells, some or one of which might have the chromosome complex necessary for continued

proliferation, abnormal inter-actions, and to cancer formation.

The abnormal activities of cancer cells, together with the products of necrosis present in every cancer, may induce cell division and the formation of cells with the right chromosome complex for cancer origin, in neighboring tissues, and so start up secondary or tertiary growths from the primary, thus giving rise to the phenomenon occasionally met with in transplanted tumors of change in type, carcinoma into sarcoma, for example, as Bashford has found.

The varying frequency of cancer in different organs or tissues depends, according to this theory, upon the frequency of mitotic divisions in the normal tissues; the age incidence of cancer, upon the abnormal divisions which accompany physiologically weakened cells, as in the case of protozoa in "depression" periods.

In his treatment of the theory Boveri gives its application to most of the well-known phenomena met with in cancer growth, and meets some of the arguments which have been brought against it. From the nature of the case the theory is difficult if not impossible to analyze by direct experiment, and for this reason, as well as for its impracticability, it is probable that the hypothesis will not be favorably received by the medical profession.

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A Text-book of Geology, for use in mining schools, colleges and secondary schools. By JAMES PARK, Professor of Mining in the University of Otago, New Zealand. London, Charles Griffin & Co. 1914. 8vo. Pp. xvi + 598, Figs. 263, Pls. 70.

Professor Park has already become well-known to teachers and students of geology in America by his writings upon mining geology. His cosmopolitan attitude and broad sympathies are attested in the present text-book by a frontispiece from the Grand Canyon of the Colorado, and by acknowledgments, in his preface, to the director of the U. S. Geological Survey for aid kindly extended. A reader on this side of the world would naturally anticipate a text-book specially prepared for Australasia, but one is pleasantly surprised to find that the anticipations are not borne out by the facts. European and American geological sections and remains of life are discussed with the same fulness as Australasian. One can not help wishing that for readers on this side of the world a little more emphasis had been laid on the latter.

Professor Park's text-book is of about the same size and scope as Scott's "Introduction to Geology," or LeConte's "Elements." It will furnish the material, along with laboratory study and suitable field trips, for one year's work in a college or scientific school. It impresses the reviewer as too advanced for secondary schools, despite its title.

There are, of course, several lines along which the subject of geology may be attacked or expounded. Broad, general processes such as erosion and deposition, elevation and subsidence, may be set forth in advance of the handling and learning of minerals and rocks. Or the teacher, as seems best to the writer, may begin with actual rocks and discuss these first; passing later to their large forms and their erosion, disturbance and order in time. A third start is possible if one considers the earth in its astronomical relations and later comes down to the terrestrial details. Professor Park begins with a summary of the science in all its bearings, and in his first chapter outlines the general astronomical relations, history, structure and the play of modifying processes. The chapter closes with seventeen summarizing propositions. Chapter II. in two pages blocks out the subdivisions of the subject and briefly reviews the teachings of several of its founders. Passing then to denudation and the destructive and constructive effects of streams, oceans, and the resulting general rock structures, nine chapters, or about one third the work, are utilized before the rock-forming minerals and the rocks themselves are specifically taken up. One may question if it would not be clearer to a student if the rock-making minerals and the rocks themselves, as formed of them, could

not be most wisely studied first, as they can be, without extended reference to other parts of the subject; and then knowing the raw materials with which forces and processes deal, the student can most intelligently follow out the various modifications produced upon them by the geological agents.

Professor Park does not take up rocks as objects in and of themselves, but views them as products of geological processes. Thus, sedimentary rocks are first outlined following the introductory chapters already mentioned, and even after joints, faults and cleavages have been described. Igneous rocks are introduced by a preliminary chapter on volcanoes and volcanic action. Before the individual rocks are taken up we find the topics—alteration, magmatic differentiation and Atlantic and Pacific types discussed, inevitably with the use of rock names with whose significance the student can not yet be familiar. In these particulars it seems to the reviewer that the natural order of treatment is reversed.

A chapter on fossils and a following one on conformity and unconformity lead up to the great subject of stratigraphical geology which forms Part II., and to which fifteen chapters or more than one third the work are devoted. One hails with satisfaction this recognition of the great stratigraphical part of the subject, by one who writes primarily for mining schools. The tendency to minimize this enormously important branch of the subject in favor of purely structural and dynamic portions has become pronounced in later days, and yet mistakenly. The great conceptions of older and younger strata, of succession in time, of recognition by organic remains; of the growth of land masses, are all fundamental to the applications of the subject as well as to its proper understanding. The treatment is well balanced and the succession of living forms is brought out by reasonably full numbers of illustrations. Sections are given for all the better explored portions of the globe.

Part III., Economic Geology, embraces two very condensed chapters, one relating to mineral deposits of all kinds and one on the methods of field work and geological surveying. Besides two brief appendices on special field methods, a condensed bibliography of geological works, classified by subjects, is given at the close of the work. All in all, Professor Park's work is well written, interesting, and will prove a serviceable text-book.

J. F. Kemp

BOTANICAL NOTES

A STUDY OF A DESERT BASIN

Several months ago there appeared from the Carnegie Institution of Washington, as "Publication No. 193" an interesting paper entitled "The Salton Sea," by Dr. D. T. MacDougal and his collaborators. It fills a quarto volume of nearly two hundred pages, and is illustrated by thirty-two full-page plates, and four text figures.

The whole book is full of interest to the scientific reader, and especially to the geologist and geographer, as shown by the titles of the chapters, "The Cahuilla Basin and Desert of the Colorado"; "Geographical Features of the Cahuilla Basin"; "Sketch of the Geology and Soils of the Cahuilla Basin"; "Chemical Composition of the Water of Salton Sea, and its Annual Variation in Concentration," etc. Several of the chapters, including the major part of the volume, are devoted to botanical aspects connected with the formation and recession of the limits of the Salton Sea. And here it may be remarked that this sea is in southern California, and occupies a portion of a great desert depression of the earth's surface below sea level. The sea was formed a few years ago by an inrush of water from the Colorado River which flooded an area of over four hundred square miles of the lower portions of the Cahuilla Valley. Since then the sea has been subsiding, and this fact has enabled the botanists to study the incoming vegetation under the peculiar conditions here found.

The distinctly botanical chapters are those on the "Behavior of Certain Microorganisms in Brine"; "The Action of Salton Sea Water on Vegetable Tissues"; "Plant Ecology and Floristics of Salton Sink"; "Movements of

Vegetation due to Submersion and Desiccation of Land Areas in the Salton Sink," and the final "General Discussion." In the third of these there is given a catalogue of 202 species of plants collected in the Salton Sink. Of these, 23 species are lower (spore-bearing) plants, while 179 are seed-bearing. Of the seed-plants 131 are indigenous, and 48, introduced, the latter almost wholly confined to the reclaimed areas (by irrigation and cultivation), and it is said that in no case have they been able to intrude where natural (*i. e.*, desert) conditions remain.

In the fourth chapter "the main thesis has been the manner in which seed-plants were carried into moist zones or strands around the receding lake which had been completely sterilized by immersion in the salt water." During the six years of close observation five trees, 17 shrubby species, and 38 herbaceous forms appeared upon the beaches of the receding lake. Lists are given of the earlier species to appear on the newly emersed beaches, but their significance is hard to understand, no doubt because of the many factors entering into the problems of dissemination, succession, elimination, etc. The transformation of a waterless desert of excessively high temperature into a saline lake with broad beaches, which range through all degrees of moisture from soft mud to almost complete desiccation, involves a great number of physical and biological factors, and this paper is a notable contribution to this phase of botany, which will be of interest to all ecologists.

VASCULAR PLANTS OF OHIO

THE state of Ohio is fortunate in having had for so many years a succession of systematic botanists who have gone over their territory again and again until its higher plants are now very well known. Fifteen years ago the lamented Professor W. A. Kellerman with the help of a considerable number of contributors published the "Fourth State Catalogue of Ohio Plants," and now his successor, Professor J. H. Schaffner, issues another list under the title "Catalogue of Ohio Vascular Plants."[1] As indicated by its title it is confined to the higher plants, and includes 2,065 species, "about one fourth of which are non-indigenous."

The nomenclature conforms mainly to that of the second edition of Britton and Brown's "Illustrated Flora of the Northern United States, Canada, and the British Possessions," and the arrangement is in accordance with the well-known phyletic classification proposed by the author of the publication. Thus the phyla are Ptenophyta (Ferns, 49 species); Calamophyta (Horsetails, 8 species); Lepidophyta (Lycopods, 8 species); Strobilophyta (conifers, 11 species); Anthophyta (Flowering Plants, 1,989 species). Among the flowering plants one finds 526 monocotyledons, against 1,463 dicotyledons. Again we find 161 sedges (Cyperaceae), and 178 grasses (Graminaceae). So, in the dicotyledons we find 72 mustards (Brassicaceae); 94 rosaceous plants (Rosaceae, in the wider sense); 87 legumes (Leguminosae, in the old sense, although listed under Fabaceae); 6 ragweeds (Ambrosiaceae); 202 composites (Helianthaceae); 25 chicories (Cichoriaceae).

A convenient map of Ohio showing the counties, and a full index complete this notable catalogue.

A STUDY OF A CARBONIFEROUS FLORA

IN a paper entitled "The 'Fern Ledges' Carboniferous Flora of St. John, New Brunswick," published as Memoir 41, of the Geological Survey of Canada (1914) Dr. Marie C. Stopes gives descriptions of the species of plants from these interesting deposits. The genera *Calamites, Asterophyllites, Annularia, Sphenophyllum, Lepidodendron, Sigillaria, Stigmaria, Psilophyton, Sphenopteris, Crossotheca, Diplothema, Oligocarpia, Pecopteris, Alethopteris, Megalopteris, Adiantides, Neuropteris, Trigonocarpum, Rhacopteris, Sporangites, Pterispermostrobus, Whittleseya, Dicranophyllum, Cordaites, Poacordaites, Dadoxylon, Cordaianthus* and *Cardiocarpon* are represented by one or more species. Many of these are illustrated by half-tone reproductions

[1] Ohio State University Bulletin, No. 24.

of photographs of the actual specimens. Since these half-tones have not been "touched up" they must prove of the greatest value to students of Carboniferous plants.

A USEFUL SOCIETY

The Sixth Annual Report of the "Quebec Society for the Protection of Plants from Insects and Fungous Diseases" (Quebec, 1914), calls attention to a society that must prove to be most useful to the people of the province of Quebec in particular, as well as of all eastern Canada in general. The report itself covers less than a hundred pages, and yet it includes more valuable articles than many much larger reports. Thus among botanical papers there is a short, crisp report of the committee on the flora of the province of Quebec recommending the early publication of a new "Flora of Quebec"; another on Downy Mildews; still others on Some Plant Diseases of 1913; Storage Rots of Potatoes and Other Vegetables; A Bacterial Soft Rot of Turnips; Injury and Abscission of *Impatiens sultani*. One can not help feeling that these Canadians have managed to organize a most useful society, for which they deserve to be congratulated.

Charles E. Bessey
The University of Nebraska

SPECIAL ARTICLES

THE ELECTRIC MOTOR NERVE CENTERS IN THE SKATES (RAJIDÆ)

While the electric lobes of the brains of torpedos, with their massed motor nerve cells of the electric apparatus, are classic subjects of study, and while the physiologically corresponding motor centers of the central nervous system have been described superficially in *Malopterurus*, *Gymnarchus* and *Gymnotus*, the motor nerve apparatus of the other three types of electric fishes (two Teleosts) have never been adequately worked out. The writer has recently worked on this nerve center of the electric apparatus in the skates with results that promise to be of interest.

Ewart has already described a motor electric nerve cell from Raja, but it is not certain that the cell, which he figures and describes in his short report in the *Proc. Royal Soc.*, Vol. 53, pp. 388–391, is a motor nerve cell belonging to the electric organ or a motor nerve cell belonging to the muscle that surrounds the electric organ.

The writer examined the spinal cords of eleven species of skates and found remarkable cells placed in the anterior horn of the cord at various regions which were all opposite the well-known spindle-shaped electric organs found in the tail and lower body of this fish. While these cells were placed thus in the cord among other nerve cells and corresponded in their anterior-posterior distribution with the extent of the electric organ, yet their cytological character was such that it could scarcely be believed that they were nerve cells at all. They are of unusually large size, irregular in configuration, with many angles and projecting points some of which might be nerve processes. The large cytoplasmic body contains an irregular branching and lobular nucleus containing much chromatin but no definite plasmosome, the opposite condition to that found in most nerve cells. This chromatin is distributed in the form of numerous (several hundred) masses of considerable size, evenly and regularly strewn through the caryoplasm.

This type of nucleus is so unusual for a nerve cell that these cells were traced backward through a series of embryonic skates to their origin, which proved to be the same as the other motor nerve cells of the anterior horn. Stages were clearly traced that showed them being differentiated from these other cells at an early stage of the embryo within the egg. The physiological activity of these large cells was evidenced by the formation of series of vacuoles which coalesced into larger vacuoles that finally condensed and precipitated their contents into a number of heavy, homogeneous granules which were discharged from the cell in a ventral direction and became distributed through and around the tissues of the gray matter. This material appears to be finally absorbed by the blood. Its composition has not yet been determined.

Work on this whole apparatus and its products is being pursued by Mr. C. C. Speidel and the writer to determine its structure and function, which is supposed to have some relation to the electric apparatus of the skates, even if it does not prove to be the motor nerve cells of this apparatus.

ULRIC DAHLGREN

THE EFFECT OF STORAGE IN RIVER WATER (STERILIZED) ON THE PRODUCTION OF ACID IN CARBOHYDRATE SOLUTIONS BY THE BACILLUS COLI GROUP

DURING the last decade, the fermentation of the various carbohydrates with the production of acid and gas has been used almost exclusively for dividing the *Bacillus coli* group into many subdivisions. Theobald Smith (1893) seems to have been the pioneer in this field by his division of the colon group by the use of saccharose. Of the later workers, Winslow and Walker (1907) and MacConkey (1905) seem to have done the most careful work. MacConkey divided the *Bacillus coli* group into four subgroups by the use of dulcite and saccharose according to the following scheme:

	Saccharose	Dulcite
B. coli communis ..	—	+
B. coli communior ..	+	+
B. coli aerogenes ...	+	—
B. coli acidi lactici.	—	—

In 1909 MacConkey further subdivided the groups by the addition of motility and liquefaction of gelatine to his tests. Jackson (1911) in America subdivided MacConkey's original scheme by the use of mannite, raffinose, nitrate reduction, indol production, motility and other similar reactions. The fermentation of carbohydrates certainly offers a fruitful field for the classification of the *Bacillus coli* group, but we must soon decide just what the limits of fermentation must be, for the list of carbohydrates now in use is a long one and increasing steadily. The question will soon come to the front, "Are these fermentations of the various carbohydrates permanent functions of the organisms?" Horrocks (1903) found that members of the *Bacillus coli* group which were kept in sterilized sewage and Thames River water as well as in well water showed only a weak production of indol and a delayed action on milk. Peckham (1897) also found that the production of indol is variable. The purpose of the present work was to determine the permanency of acid production in carbohydrate solutions by the *Bacillus coli* group in stored river water. Three organisms of the original MacConkey scheme were used, namely, *B. coli communis, acidi lactici, aerogenes.*

Procedure

Water was taken from the Hudson River near the outlets of a sewer and 100 c.c. was poured into 30 bottles of 250 c.c. capacity. The water was sterilized and the sterilization tested by plating out respective samples. Pure agar cultures of *B. coli communis, aerogenes, acidi lactici* were emulsified in sterilized water. One cubic centimeter of this emulsion was placed in each bottle thus giving ten bottles of *communis, acidi lactici* and *aerogenes.* These bottles were stored away in a dark closet at 20° C. At various intervals inoculations were made into the carbohydrate solutions and titrations made at the end of the twenty-fourth hour or as near as possible to that period. During the course of the experiment the following carbohydrates were used: Dextrose, lactose, raffinose, saccharose, salicin, maltose and mannite.

The carbohydrates and other media used during the work were made according to standard methods of water analysis, report of 1905. Liebig's Meat Extract (3 grams to the liter) was used in place of meat and gave entirely satisfactory results. The method used in titrating the cultures followed standard methods in detail. Five cubic centimeters of the carbohydrate solution to be tested and 45 cubic centimeters of distilled water were placed in a casserole and boiled briskly for 1 minute. One cubic centimeter of phenolphthalein was added as indicator, and titration was made into the hot solution with N/20 NaOH. All results are expressed in per cent. normal. All cultures were incubated at 37° C. and titrated at the twenty-fourth hour. Controls were run

in all cases. The author wishes to thank Meyer M. Harris for the routine analyses.

TABLE I

Averages of the Production of Acid by Bacillus coli communis

Length of Storage in Weeks	Dextrose	Lactose	Maltose	Saccharose	Mannite	Raffinose	Salicin
0	2.71[1]	2.02	2.15	No acid produced	2.87	No acid produced	1.83
1	2.73	2.12	2.01		2.88		1.73
2	2.71	2.09	2.01		2.82		1.69
3	2.79	1.77	2.00		2.36		1.54
4	2.78	1.81	2.03		2.34		1.52
6	2.76	1.78	2.11		2.35		1.54
8	2.44	1.88	1.81		2.34		1.49
10	2.39	1.84	1.78		2.17		1.38
14	2.41	1.98	1.77		2.09		1.39

TABLE II

Averages of the Production of Acid by Bacillus coli aerogenes

Length of Storage in Weeks	Dextrose	Lactose	Maltose	Saccharose	Mannite	Raffinose	Salicin
0	2.76[2]	1.95	1.97	2.08	2.63	2.03	No acid produced
1	2.80	2.22	2.09	2.64	2.62	1.48	
2	2.77	2 09	2.16	2.66	2.49	1.53	
3	2.81	2.05	2.03	2.17	2.34	1.68	
4	2.75	1.86	1.96	1.90	2.30	1.61	
6	2.78	1.75	2.03	1.94	2.29	1.58	
8	2.47	1.76	2.03	1.95	2.32	1.60	
10	2.34	1.77	1.79	1.82	2.16	1.59	
14	2.27	1.80	1.81	1.77	2.13	1.58	

TABLE III

Averages of the Production of Acid by Bacillus coli acidi lactici

Length of Storage in Weeks	Dextrose	Lactose	Maltose	Saccharose	Mannite	Raffinose	Salicin
0	lost	1.96	2.46	No acid produced	2.82	No acid produced	1.65
1	2.80[3]	2.00	2.14		2.62		1.19
2	2.81	2.00	2.15		2.69		1.46
3	2.76	1.81	2.24		2.39		1.44
4	2.74	1.83	2.20		2.29		1.39
6	2.76	1.91	2.29		2.32		1.38
8	2.22	1.83	2.15		2.27		1.42
10	2.06	1.85	1.89		2.23		1.33
14	2.05	1.82	1.86		2.16		1.34

[1] Each result is the average of ten titrations.
[2] Each result is an average of ten titrations.
[3] Each result is an average of ten titrations.

Conclusion

From the tables of averages it may be seen that storage for a period of 14 weeks in sterilized Hudson River water (in tidal area) has very little effect upon the amount of acid produced in dextrose, lactose, saccharose, maltose, mannite, salicin and raffinose by various members of the *Bacillus coli* group, *i. e., Bacillus coli communis, aerogenes* and *acidi lactici*, which indicates that production of acid is a permanent characteristic of the *Bacillus coli* group. The slight decline of acid production may be due to diminished vitality of the organisms as a result of long storage in the water.

WM. W. BROWNE
THE COLLEGE OF THE CITY OF NEW YORK

THE WASHINGTON MEETINGS OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS AND RELATED ORGANIZATIONS

THE twenty-eighth annual convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington, D. C., November 11–13, 1914, and accompanied as usual by meetings of about half a score of related organizations, brought together college presidents, experiment station and extension directors, and workers in many fields of agricultural science to the number of approximately five hundred. The sessions of the various bodies were well attended and enthusiastic, and the programs included much of interest to educators, scientific men and the general public.

The complete list of organizations included in these meetings was as follows: American Association of Farmers' Institute Workers, November 9–11; American Farm Management Association, November 9, 10; American Society of Agronomy, November 9, 10; National Association of State Universities, November 9, 10; American Association for the Advancement of Agricultural Teaching, November 10; Society for the Promotion of Agricultural Science, November 10; American Society of Animal Production, November 10,

11; Land-grant Engineering Association, November 11–13; Association of Official Seed Analysts, November 12, 13; Association of Feed Control Officials of the United States, November 13, 14, and Association of Official Agricultural Chemists, November 16–18.

The general sessions of the Association of American Agricultural Colleges and Experiment Stations opened November 10. In an address of greeting, the Secretary of Agriculture, Hon. D. F. Houston, spoke of the increasing realization of the unity of interests of the department and the agricultural colleges, and of the widened opportunities for service through this and through the passage of the Smith-Lever extension act. He also emphasized the additional responsibilities incurred, and especially the difficulty of securing trained men to take up these new undertakings. The development of strong rural economics courses to provide workers in such lines as marketing studies and the making of country life more attractive was strongly urged upon the agricultural colleges as well as their assumption of a general position of leadership in country life matters.

In the report of the bibliographer, Dr. A. C. True, of the Office of Experiment Stations, discussed the form of extension publications, calling attention to the great diversity of practise now prevailing, and suggesting some changes in the interests of uniformity, increased availability, and ease of preservation of these publications. Subsequently, a series of recommendations from the agricultural libraries section of the American Library Association as to title pages, pagination and similar matters in college and station publications in general received the consideration and approval of the executive committee of the association.

For the standing committee on instruction in agriculture, Dr. True reported as chairman on farm practise requirements as a part of the 4-year college course. Much diversity among institutions was discovered but the importance of the subject was strongly emphasized. It was pointed out that failure to make provision for such practise decreases the effectiveness of instruction in agriculture, and that students who are permitted to graduate without it often bring upon the colleges merited unfavorable criticism. The report is to be printed as a separate at an early date.

Dr. H. P. Armsby, of Pennsylvania, reported for the committee on graduate study, dealing especially with the Sixth Graduate School of Agriculture successfully held at the University of Missouri, June 29 to July 24. A policy of concentration upon a few subjects at the school was favored as well as the provision of some form of credit for work accomplished, and the need of greater attention by the colleges and stations to ways for facilitating the attendance of the younger members of their staffs at this school was pointed out.

Reports were also submitted by the standing committees on college, experiment station and extension organization and policy. A plan for student and faculty cooperation being tried at the Iowa State College in such matters as the upkeep of the grounds, sanitation and other minor improvements, and the protection of property was briefly reported by the college committee. This committee also summarized a questionnaire as to student character records which indicated a general belief in the desirability of such records but little uniformity as to methods. The experiment station committee emphasized the need for a sharp differentiation of the field of the station work from that of extension agencies, limiting the scope of the station to the discovery of new facts and methods and the testing of them to a point sufficient to establish their general truth and application. The prompt publication of results and the preservation of records in such form that in case of necessity the work may be taken up by others and the wider utilization of the *Journal of Agricultural Research* were also recommended. The report of the extension committee consisted largely of descriptions and definitions of terms commonly used in extension work. The question of general agricultural terminology is also to receive further study by a special committee subsequently authorized by the association.

The joint committee of the association and the U. S. Department of Agriculture on projects and correlation reported through Dean F. B. Mumford, of Missouri, that the committee had examined about 1,300 projects submitted by the state institutions and about 1,000 from the Department of Agriculture with a view to their possible correlation. Dr. K. F. Kellerman, of the department, for the joint committee on publication and research, explained the policies of the *Journal of Agricultural Research*, now open to experiment station workers, and urged a wider participation by them.

The evening sessions of the association were devoted largely to the address of the president, Dr. A. C. True (already printed in SCIENCE) and to addresses by E. L. Morgan, of Massachusetts, and Miss Elizabeth B. Kelley, of Wisconsin. Professor Morgan described an interesting experiment in rural community planning inaugurated in a typical New England village by the Massachusetts Agricultural College, whereby a strong community spirit was developed and great improvement effected in agricultural practise and marketing, transportation facilities and other civic affairs, in education, and in the adoption of an all-the-year-round plan for community recreation. Miss Kelley spoke on home economics in extension work and emphasized the importance of educating men as well as women along this line, outlining some of the ways which have been found effective in bringing improved methods into the home.

One of the general sessions was set aside for the discussion of problems in connection with the administration of the Smith-Lever extension act. At this session, President W. O. Thompson, of Ohio, chairman of the executive committee, reviewed the passage of the measure and Dr. True, for the States Relations Committee of the U. S. Department of Agriculture, described its practical workings. The matter was further discussed by Dean C. F. Curtiss, of Iowa, President A. M. Soule, of Georgia, A. D. Wilson, of Minnesota, President Benjamin Ide Wheeler, of California, and others. Hon. Carl Vrooman, Assistant Secretary of Agriculture, also made a brief address at this session in which he pointed out the need of extension work. At its close the association was received at the White House by President Wilson.

At the final session, a report was made by President Brown Ayres, of Tennessee, for the executive committee, on the provisions and status of the Smith-Hughes bill for federal aid to vocational education, including an explanation of the work of the Federal Commission on Vocational Education. Commissioner Claxton and others also discussed the scope and details of the bill. The association declared itself in favor of federal aid to vocational education along the general lines of the bill and instructed the executive committee to cooperate with other agencies in perfecting the measure and aiding in its passage.

Various measures relative to military instruction in the land-grant colleges were referred to the executive committee for consideration. An engineering division was established in the college sectional meeting with provision for either separate or joint programs.

Officers for the ensuing year were chosen as follows: President, E. A. Bryan, of Washington; Vice-presidents, J. H. Worst, of North Dakota, T. F. Hunt, of California, C. D. Woods, of Maine, P. H. Rolfs, of Florida, and C. A. Lory, of Colorado; Secretary-treasurer, J. L. Hills, of Vermont; Bibliographer, A. C. True, of Washington, D. C.; Executive Committee, W. O. Thompson, of Ohio, chairman, H. J. Waters, of Kansas, Brown Ayres, of Tennessee, W. H. Jordan, of New York, and H. L. Russell, of Wisconsin.

The time and place of the next meeting were left as usual with the executive committee.

Afternoon sessions were held by the sections on college work and administration, experiment station work and extension work. In the college section, the initial paper was on "The Relation of the Agricultural College to Instruction in Agriculture and Home Economics in Secondary and Rural Schools," and "What the College Can Do to Promote General Rural School Improvement." In this paper, President E. T. Fairchild, of New

Hampshire, suggested that the agricultural colleges aid in securing the consolidation of scattered rural schools and their more liberal financial support, undertake a propaganda for rural high schools within the states and teachers' training classes in these schools, and favor a law requiring the teaching of agriculture in elementary schools and the training of teachers in the elements of agriculture. President Vincent, of Minnesota, also advocated summer sessions at the colleges for training rural teachers.

President D. H. Hill, of North Carolina, in a paper entitled "Some Changed Attitudes" called attention to the increasing tendency to magnify the educational value of utilitarian subjects. Inasmuch as the mere training of experts will not make leaders of men, he advocated the retention of some subjects which turn men's minds away from the purely materialistic point of view.

The cost of instruction in agricultural colleges and the relation of salaries in the division of agriculture to those of other divisions in the agricultural colleges and universities was discussed by President C. A. Lory, of Colorado. This paper described and illustrated by means of charts a system of cost keeping based on the units of semester credit, student semester credit and student recitation hour, the last named being found the most satisfactory.

President H. J. Waters, of Kansas, was elected chairman of this section for the ensuing year and President W. M. Riggs, of South Carolina, secretary.

In the experiment station section, under the topic of "Meat Production as a Factor in the Progress of Agriculture in the United States," George M. Rommel, of the U. S. Department of Agriculture, presented for Dr. A. D. Melvin and himself a paper on "Meat Production in the Argentine and Its Effect on the Industry in the United States." Although nearly 140,000,000 pounds of beef were imported from Argentina during the last year, they believed that killings are about as great as breeding conditions will warrant, and therefore need cause no serious concern to American producers. On the other hand, it was thought that Argentina offers a possible market for breeding stock deserving of increased attention. Dean F. B. Mumford discussed "Meat Production on the High-priced Corn Lands," concluding that the methods which are likely to result in decreasing the cost of meat production and thereby making it possible for the farmers of the corn belt region to produce meat animals on high priced land are to be found in developing unimproved areas of land for grazing purposes; by utilizing the by-products of the farm, particularly coarse roughage such as stover, straw and cheap hay; by the general adoption of the silo as a means of preserving corn and other crops; by feeding more sheep and hogs because of their well-known efficiency in the utilization of feed-stuffs; and lastly, by the selection of more efficient meat animals. "The Possibilities and Methods of Meat Production in the South" were summarized by D. T. Gray, of North Carolina, who pointed out the advantages of this region in cheap lands and labor, mild climate and long growing season, and comparative nearness to markets, and believed that success was to be expected upon adapting the industry closely to southern conditions as to feeds, buildings, etc.

Dr. E. W. Allen, of the Office of Experiment Stations, explained the administration of experiment station work by projects. The project properly defined and limited has been found a convenient unit in planning, financing and supervising station work. It provides a record of the stations' activities, assists in defining the scope of this work and tends toward general economy and efficiency. The discussion following brought out a general concurrence as to the merits of the project system. A paper entitled "How Can American Agricultural Experiment Stations Gain Higher Standing as Institutions for Scientific Research," was read by Director S. B. Doten, of Nevada. The selection of high-grade men and the careful conserving of their time, and the provision of a scientific atmosphere were among the means suggested.

The section officers elected for the ensuing

year are Dean E. A. Burnett, of Nebraska, chairman; Director W. R. Dodson, of Louisiana, secretary; and W. H. Beal, of the Office of Experiment Stations, recording secretary.

The section on extension work held a joint session with the American Association of Farmers' Institute Workers, at which Dr. A. C. True took up the question of the use of the Smith-Lever fund for farmers' institutes as a phase of extension work. In this he drew attention to the strictly educational character of the extension work contemplated by the act and the great stress laid on practical demonstrations. The farmers' institutes, therefore, come within the provisions of the law only so far as they may be agencies through which the colleges can carry on work of this type. Where the institute system is directly connected with the colleges it is believed that they may be easily modified and restricted in scope so as to give them a distinctive place in the extension system. In states where the institutes are under the direction of other agencies, their maintenance apparently does not come within the provisions of the law, though there may be cooperation and participation by the college staffs. The eventual establishment of a county agent system will also affect the situation. Conditions as to farmers' institute administration at present vary so widely in different states that apparently the first need is a standardization of the institute.

The relation of farmers' institutes to organized extension agencies was also discussed by G. I. Christie, of Indiana. He believed that the institute is fulfilling a practical need but should be correlated with other extension work and brought under the supervision of the colleges.

As an example of a model farmers' institute address, Director C. E. Thorne, of Ohio, gave a paper on "Maintaining Crop Production." Former Dean L. H. Bailey, of Cornell University, closed the joint session with an address on "The Present Responsibility of the Rural People." This had special reference to the conditions brought about by the European war and emphasized the political responsibility of rural people in the progress of the nation.

The extension section also took up the problem of placing county agents in effective touch with farmers. C. B. Smith, of the States Relations Committee, indicated as among the essentials the employment of a well-trained representative, the making of a complete survey of the agricultural conditions, and the securing of the cooperation of the existing organizations, working through groups wherever possible. C. R. Titlow, of West Virginia, also advocated the utilizing of existing organizations, both official and non-official, and presented a chart showing graphically the correlation of the various agencies.

C. D. Jarvis, of Connecticut, discussed the planning of extension work by means of definite written projects, favoring in addition to the federal requirements a seasonal schedule for workers. K. L. Hatch, of Wisconsin, submitted a report from the committee on the training of extension teachers, advocating the provision of technical training along the special line of prospective extension work and instruction in the art of teaching. He suggested that the time necessary for this training might be secured by eliminating requirements of foreign languages and mathematics. Teachers of approved ability in secondary agricultural schools were suggested as a promising source of supply for extension work. The officers elected for the ensuing year were R. D. Hetzel, of Oregon, chairman; C. R. Titlow, secretary, and John Hamilton, of Pennsylvania, recording secretary.

Howard L. Knight

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Philadelphia, during convocation week, beginning on December 28, 1914:

American Association for the Advancement of Science.—President, Dr. Charles W. Eliot, Harvard University; retiring president, Professor Edmund B. Wilson, Columbia University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary,

Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.; secretary of the council, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.

Section A—Mathematics and Astronomy.—Vice-president, Professor Henry S. White, Vassar College; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Anthony Zeleny, University of Minnesota; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Provost Edgar F. Smith, University of Pennsylvania; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Albert Noble, New York; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor U. S. Grant, Northwestern University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor Frank R. Lillie, University of Chicago; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Dr. G. P. Clinton, Connecticut Agricultural Experiment Station; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Dr. Clark Wissler, American Museum of Natural History; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Richard Mills Pearce, University of Pennsylvania; secretary, Dr. Donald R. Hooker, Johns Hopkins Medical School, Baltimore, Md.

Section L—Education.—Vice-president, Professor Paul H. Hanus, Harvard University; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor L. H. Bailey, Cornell University; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

The American Physical Society.—Convocation Week. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 29. President, Professor C. R. Mann, Carnegie Foundation, New York City; secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 31. President, Professor Samuel F. Clarke, Williams College; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 29–31. President, Professor C. E. McClung, University of Pennsylvania; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Society of American Bacteriologists.—December 29–31. President, Professor Charles E. Marshall, Massachusetts Agricultural College; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

The Entomological Society of America.—December 31–January 1. President, Professor Philip P. Calvert, University of Pennsylvania; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 28–31. President, Professor H. T. Fernald, Amherst College; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Geological Society of America.—December 29–31. President, Dr. George F. Becker, U. S. Geological Survey, Washington, D. C.; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Paleontological Society.—December 29–31. President, Dr. Henry F. Osborn, American Museum of Natural History, New York City; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Botanical Society of America.—December 29–January 1. President, Dr. A. S. Hitchcock, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 29–January 1. President, Dr. Haven Metcalf, U. S. Department of Agriculture; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Fern Society.—December 28–29. Secretary, Charles A. Weatherby, 749 Main St., East Hartford, Conn.

Sullivant Moss Society.—December 30. Secretary, Edward B. Chamberlain, 18 West 89th St., New York, N. Y.

American Nature-Study Society.—December 30–31. Secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Alpine Club.—January 2. Secretary, Howard Palmer, New London, Conn.

American Association of Official Horticultural Inspectors.—December 29–30. Chairman, Dr. W. E. Britton, New Haven; secretary, Professor J. G. Saunders, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Charles Brookover, Little Rock, Ark.; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

The American Anthropological Association.—December 28–31. President, Professor Roland B. Dixon, Harvard University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. President, Dr. P. E. Goddard, American Museum of Natural History, New York City; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor R. S. Woodworth, Columbia University; secretary, Professor R. M. Ogden, University of Tennessee, Nashville, Tenn.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The American Association for Labor Legislation.—December 28–29. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

Society of Sigma XI.—December 29. President, Professor J. McKeen Cattell, Columbia University; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

ST. LOUIS

The American Physiological Society.—December 28–30. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor Graham Lusk, Cornell University Medical School; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society for Pharmacology and Experimental Therapeutics.—December 28–30. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society for Experimental Pathology.—December 28–30. President, Professor Richard M. Pearce, University of Pennsylvania; secretary, Dr. George L. Whipple, San Francisco, Cal.

CHICAGO

American Mathematical Society.—December 28–29. President, Professor E. B. Van Vleck, University of Wisconsin.

The Association of American Geographers.—December 29–31. President, Professor A. P. Brigham, Colgate University; secretary, Professor Isaiah Bowman, Yale University, New Haven, Conn.

The American Philosophical Association.—December 28–30. President, Professor J. H. Tufts, University of Chicago; secretary, Professor E. G. Spaulding, Princeton, N. J.

PRINCETON

The American Economic Association.—December 28–31. President, Professor John D. Gray, University of Minnesota; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW YORK CITY

The American Mathematical Society.—January 1–2. President, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor F. N. Cole, 501 West 116th St., New York City.